United States
Department of
Agriculture

Forest Service

Pacific
Northwest
Region

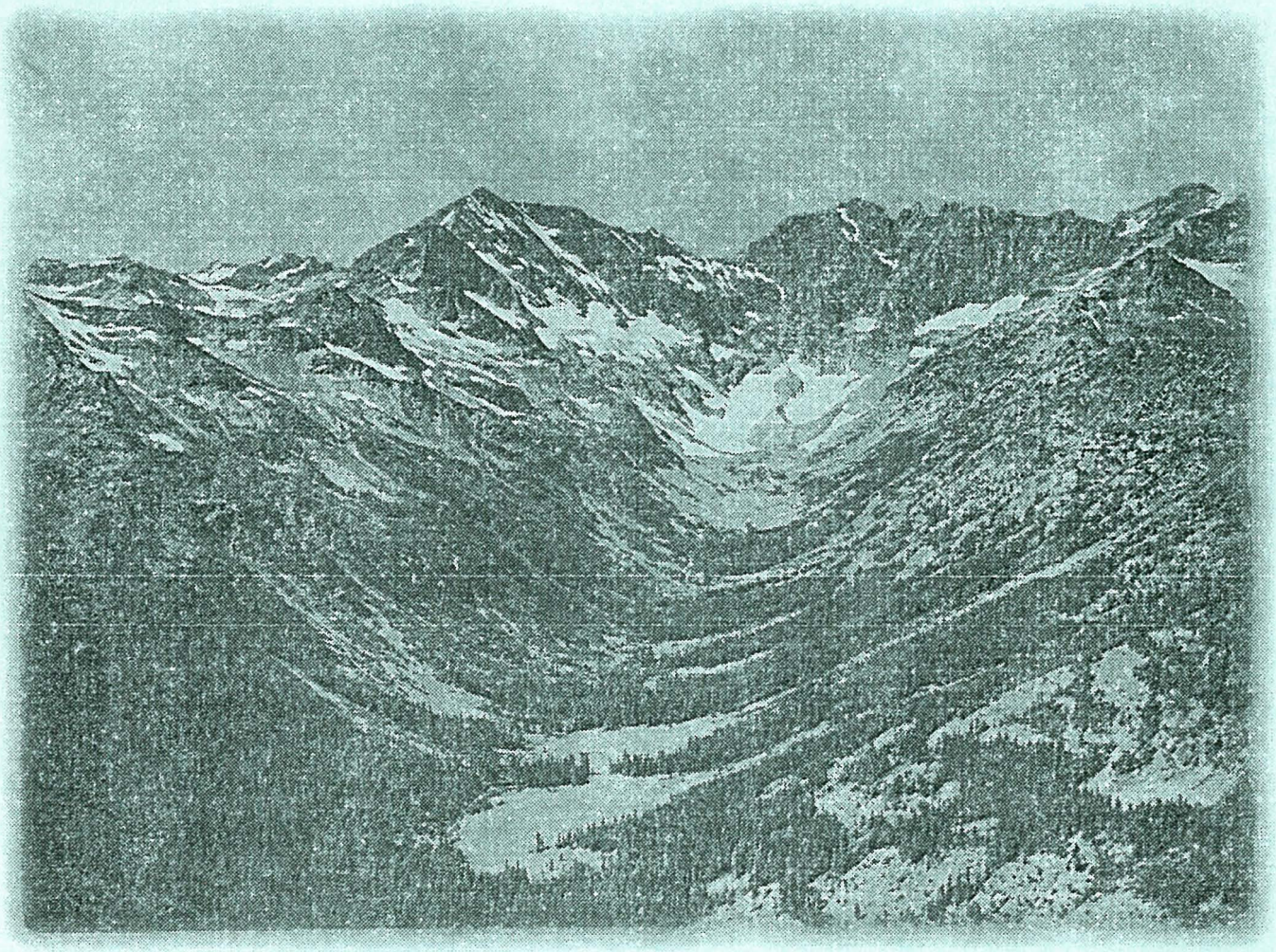
April 1996

Watershed Assessment

Entiat Analysis Area

Version 2.0

Wenatchee National Forest



Applicable to all National Forest and Bureau of Land Management lands within Entiat and Mad River key watersheds, and adjacent Columbia River tributaries.

WATERSHED ASSESSMENT

Entiat Analysis Area

Version 2.0
April 1996

Prepared by
Entiat Watershed Analysis Teams

Submitted by	Analysis Team Leader, Version 1.0	4/15/96 Date
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Reviewed by	Forest Soil Scientist	4/15/96 Date
Reviewed by	Forest Hydrologist	4/15/96 Date
Reviewed by	Forest Landscape Architect	4/15/96 Date
Reviewed by	Forest Ecologist	4/15/96 Date
Approved by	acting Forest Supervisor Wenatchee National Forest	4/15/96 Date
Approved by	Area Manager Bureau of Land Management	4/15/96 Date

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Note: Tabular values for acreage may show minor differences in totals due to variability in Geographic Information System runs and other calculation procedures.

MAP SOURCES

Watershed Assessment
Entiat Analysis Area

A number of maps and related GIS products were used in this analysis. In order to save on reproduction and distribution costs, this document does not include copies of these map resources. Following is a list of the primary maps used by the analysis teams. *

MAP PRODUCT	*SOURCE* **
Percent Slope by Category (0-40%, 40-60% & >60%)	H. Maekawa, SO
Land Allocation	SO GIS
Fire Intensity	Entiat RD GIS
Visual Quality Objectives	H. Maekawa, SO
Base Map (Hydrography, Roads, Trails)	Entiat RD GIS
Existing Visual Condition	H. Maekawa, SO
Vegetation Successional Stages (PMR)	Entiat RD GIS
Riparian Areas	Entiat RD GIS
Entiat RD Fish Distribution	Entiat RD GIS
Entiat River Core Sampling Sites	P. Archibald, Entiat RD
Landtype Association Maps	C. Davis, SO;Entiat RD GIS
SWF Stratification Map	Entiat RD
Fish Production Units	Entiat RD GIS
Deer Winter Range	SO GIS
Priority Habitat System and data base	SO GIS
Large (100 acre +) Fires on WNF (1970-1994)	Entiat RD GIS

MAP SOURCES (Continued)

MAP PRODUCT	*SOURCE* **
Potential Suitable Range (Cattle)	SO GIS
Historical Vegetation Based on Soil Survey	SO GIS; Entiat RD GIS
WNF LTA Responses Map	SO GIS
Rock Outcrop and Wetland Soils Map	C. Narcisco; Entiat RD GIS
Lakes/Wet Areas/Springs with Buffers	C. Narcisco; Entiat RD GIS
Simplified Soils Map - Entiat RD	C. Narcisco; Entiat RD GIS

* *Map Availability*: Please contact the Wenatchee National Forest Supervisor's Office or the Entiat Ranger District for more information about obtaining map materials.

Wenatchee National Forest
Supervisor's Office
215 Melody Lane
Wenatchee, WA 98801
509-662-4335

Entiat Ranger District
Wenatchee National Forest
POB 476
Entiat, WA 98822
509-784-1511

** **SO** = Supervisor's Office, Wenatchee National Forest; **GIS** = Geographic Information System; **RD** = Ranger District

EXECUTIVE SUMMARY

Process Overview

This document presents the results of both the first and second iterations of watershed assessment for the Entiat Analysis Area. The first iteration of this assessment (Version 1.0) was completed in February, 1995 and focused primarily on fire recovery. This second iteration of the assessment (Version 2.0) incorporates and updates Version 1.0 and addresses new issues related to recreation, commercial grazing and the Columbia River Tributaries adjacent to the Entiat sub-basin. **Refer to Figure ES-1 for a graphic summary of the relationship between the first two iterations of this watershed assessment.**

The analysis area for Version 1.0 consisted of the Entiat and Mad River **key watersheds**. The analysis area for Version 2.0, referred to as the "Entiat Analysis Area" in this document, includes the Entiat and Mad River key watersheds and adjacent lands referred to as the "Columbia River Tributaries." These Tributaries include the Columbia River Breaks from Swakane Creek north to Navarre Coulee, on the Entiat and Chelan Ranger Districts. Although watershed analysis is not required for management of the Columbia River Tributaries, the Wenatchee National Forest Supervisor chose to include that area in this assessment in order to maintain consistency in approach.

Fire recovery was the primary emphasis of the first iteration of this assessment. The Version 1.0 analysis was framed by six co-dominant issues and targeted at addressing specific questions related to these issues. This focus was necessary in order to meet the narrow timeframes associated with the site-specific analysis, design and implementation of recovery projects within the 140,000 acre Tyee Fire. This wildfire burned 88,958 acres of the Entiat subbasin in July, August and September of 1994. A wide range of potential projects could result from burned area recovery efforts, such as wildlife browse planting, timber salvage and road drainage improvements. This large burn area presents opportunities to harvest fire-killed trees and move the vegetative component towards a condition that is more fire resilient and sustainable. Some of these opportunities are relatively short-term, in that many of the smaller diameter trees will only retain value supporting their removal for a year or less.

In order to meet the timeframe for the first assessment, a team was chartered consisting of both Forest and District level resource specialists, as well as representatives from the Bureau of Land Management (BLM), U.S. Fish and Wildlife Service and the Chelan County Conservation District. Included along with the formation of this new team was a decision to cover both the Entiat and Mad Rivers under one Watershed Assessment and the decision to focus the scope of the analysis initially on the potential for fire recovery. The first iteration covered all National Forest (221,599 acres) and BLM lands (2,560 acres) within the Entiat subbasin.

Range and recreation-related issues were the primary emphases of the second iteration of this assessment. This iteration also addressed updates to the findings in Version 1.0 and inclusion of the Columbia River Tributaries described earlier. Watershed analysis of range and recreation-related issues was triggered by the need to complete site-specific analyses for both of these forest uses. Recovery of range resources in fire-affected allotments and the desire for interim temporary pasture have generated specific concerns for commercial grazing activities. Increasing recreational use in the watershed has generated increasing concern for resource damage and use conflicts, especially in the upper Entiat Valley.

Watershed analysis is important to ensuring that protection of aquatic systems is fitted to specific landscapes and is one of the principal means of making decisions on implementation of the Aquatic Conservation Strategy in the Northwest Forest Plan. The Aquatic Conservation Strategy approach seeks to prevent further degradation and restore habitat over broad landscapes as opposed to individual projects or small watersheds.

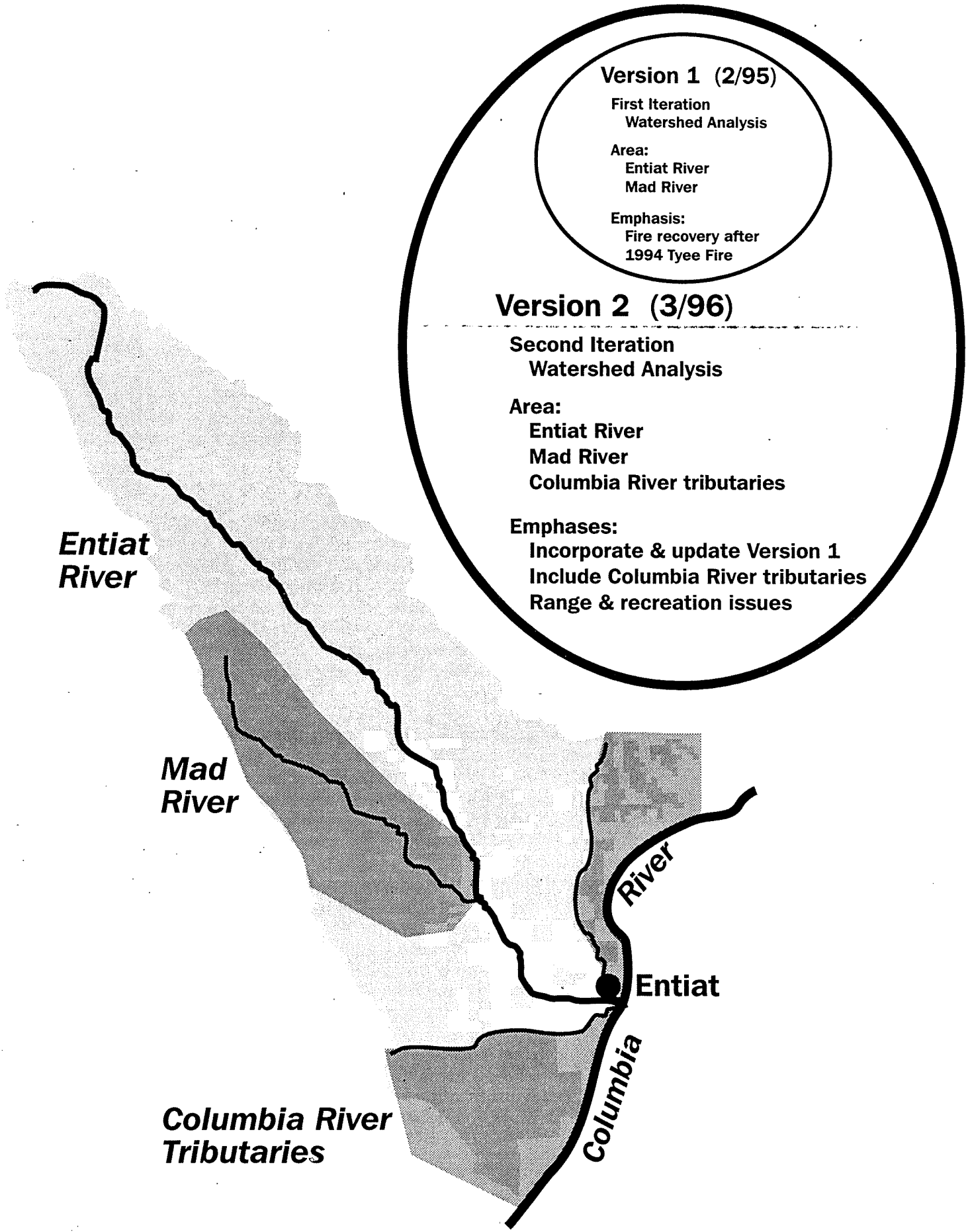

FIGURE ES-1. Relationship of the two iterations of watershed assessment completed to date for the Entiat Analysis Area in North Central Washington, 4/96.

The Entiat and Mad Rivers have been identified as part of a system of **key watersheds**, within the range of the northern spotted owl, that serve as critical refugia for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. The Entiat and Mad Rivers are Tier 1 Key Watersheds, which are designated to contribute directly to the conservation of at-risk fish species. Two anadromous "stocks-at-risk" (FSEIS VOL II/Table B6-5) and a resident bull trout population are found within the Entiat Subbasin. Entiat spring/summer chinook and summer steelhead populations are identified as "depressed" by the Washington Department of Fish and Wildlife. In addition, the summer steelhead population was rated at a "high risk of extinction" by Nehlsen et al. (FSEIS). Neither spring chinook nor summer steelhead are meeting Entiat Subbasin escapement goals as defined in the Columbia Basin System Planning Salmon and Steelhead Production Plan, Entiat River Subbasin (WDF et al. 1990). A more detailed discussion of anadromous fish spawning trends and escapement goals can be found in Appendix F-9-VI (Entiat Watershed Analysis - Fisheries Context). Bull trout have been found to be eligible for listing as endangered or threatened by the U.S. Fish and Wildlife Service and are on the Regional Forester's Sensitive Species list.

The lands ceded by the Yakama Indian Nation include the Entiat Analysis area. The Yakama Nation retained the exclusive right of taking fish in all the streams, where running through or bordering the reservation, and further secured the rights of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them; together with the privelege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land. The U.S. Forest Service has a trust responsibility to manage the forest in such a manner as to protect those treaty resources within the watershed, which include anadromous fish. Coordinated management of the fish resource is established in the 12/27/93 Memorandum of Understanding between the Wenatchee National Forest and the Yakama Indian Nation.

Watershed analysis is ecosystem analysis at the watershed scale, and is one of the principle means by which ecosystem management goals will be met. Information contained in this watershed assessment will be used to identify management strategies, design monitoring programs and develop restoration and fire recovery projects. This information will also be used to refine riparian reserve boundaries through site-specific NEPA documents. This watershed analysis is not a decision-making process; however, it does set the stage for developing specific projects and conducting site-specific (NEPA) analysis.

This Watershed Analysis meets all the requirements listed in the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (Northwest Forest Plan) and those for the PAC Fish agreement. Items not covered in this assessment are discussed in Chapter 4. For example, this analysis has not extensively addressed social issues. Social issues are important in the watershed; however, addressing them for the entire watershed was not essential to addressing the key questions related to analysis issues. Social issues will be a major focus of the Cooperative Watershed Management Planning effort concurrently being coordinated by the Chelan County Conservation District.

Both iterations followed the original eight step process as outlined in the Federal Agency Guide to Watershed Analysis, developed by the Forest Ecosystem Management Assessment Team (FEMAT). In addition to outlining the eight steps, this guide developed "analysis modules" meant to provide processes for answering commonly encountered resource issues or questions. The Wenatchee National Forest also developed additional analysis modules to deal with issues or questions not addressed by FEMAT. Some, or portions of some of these analysis modules were used in this assessment. The analysis summaries are included in Chapter 2. In order to maintain consistency in approach, the same analysis procedure was used in completing Version 2.0 of the assessment.

In Version 1.0 for example, initial review indicated that the primary issues would be related to the major changes resulting from the Tyee fire, including vegetative changes, alteration of wildlife habitat and increased risk of erosion, sedimentation and flooding. The team validated these issues and identified several others.

These changes, particularly the alteration of vegetation and the short-term opportunity presented for salvage harvest of fire-killed trees, helped narrow the focus in terms of which questions needed to be addressed in the first iteration of the Entiat analysis. Besides updating Version 1.0 findings, the second iteration (Version 2.0) focused on issues associated with the Columbia River Tributaries and the effects of recreation and commercial grazing on ecosystem function. In both iterations, key questions were identified and addressed by Vegetation, Wildlife, Soil/Water/Fish and Scenery teams (Issues, Chapter 1). These Key Questions determined which analysis modules would be used in the analysis to describe what is going on within the watershed (Existing Conditions, Chapter 2). The stage was then set for the identification of resource linkages, desired ecological conditions, and management strategies.

After hearing descriptions of conditions for each resource area, team members identified inter-relationships seen between resources (Linkages, Chapter 3). In an interdisciplinary fashion, the team then described desired ecological outcomes. An example of a desired ecological outcome is shown below.

> **Desired Ecological Outcome:** Vegetation in riparian area approximates historic conditions with a mix of mid and low level shrubs as well as deciduous trees.

Once desired ecological outcomes were identified, the team was then able to describe management strategies that would move elements of the watershed in the direction of these desired outcomes or conditions. All management strategies are presented in the tables in Chapter 3. The representative management strategy shown below relates directly to the desired outcome statement in the example above.

> **Management Strategy:** Conduct low intensity underburns through fine fuels which replicate the natural fire regime. Goal is to manage area to avoid moderate to high intensity fires.

Vegetation groups were used as the common stratification for this assessment (Strata, Chapter 1). Stratification is the process of identifying like ecological areas that can be predicted to react similarily to disturbance or management actions. Stratification helps simplify field work and analysis by identifying areas that can be evaluated as uniform units. Also, patterns of landscape form and function that define sensitivity to important environmental changes can be identified.

A parallel watershed analysis effort is being coordinated by the Chelan County Conservation District (CCCD). The CCCD Cooperative Management Plan focuses on watershed management issues associated with the private lands in the subbasin. However, completion of the CCCD Plan will also involve a total watershed view, with cooperating agencies providing support and information from their analysis processes. This second iteration of watershed assessment for Federal lands in the Entiat subbasin is being completed in concert with the CCCD cooperative planning effort.

Analysis Area Description & Findings

Please refer to the following sections of the body of this document for a summary of conditions and findings for the analysis area. These sections summarize the content of the associated appendices.

Analysis Area Description & History	Introduction	Pages 5-11
Summary of Findings - Vegetation	Chapter 2	Pages 21-23
Summary of Findings - Wildlife	Chapter 2	Pages 23-28
Summary of Findings - Soil/Water/Fish	Chapter 2	Pages 28-32
Summary of Findings - Scenery	Chapter 2	Pages 32-33
Summary of Findings - Fire	Chapter 2	Pages 33-35
Summary of Range Use Conditions	Chapter 2	Pages 36-37
Summary of Recreation Use Conditions	Chapter 2	Pages 37-38

INTRODUCTION

General Analysis Area Description

The Entiat Analysis Area consists of the Entiat subbasin and the adjacent Columbia River Tributaries from Swakane Creek north to Navarre Coulee. The area is located along the eastern slopes of the Cascade Mountains in north-central Washington (Eastern Washington Cascades physiographic province). The Entiat subbasin includes both the Entiat and Mad Rivers, **key watersheds** in the Northwest Forest Plan.

Entiat Subbasin

The Entiat River heads in a glaciated basin near the crest of the Cascade Mountains and flows southeasterly. It meets the Columbia River near the town of Entiat, about 20 miles upstream from Wenatchee in Chelan County. Topography is extremely steep and dissected. Vegetative cover is primarily forest but also includes a shrub/steppe component on the lower end and an alpine meadow component in the upper reaches.

The drainage area is about 268,000 acres. Approximately 224,000 acres of the subbasin are in public ownership, primarily National Forest, BLM lands and lands administered by the Washington Department of Fish and Wildlife. There are 1,300 acres of orchard land in the lower valley, much of it classified as prime agricultural land.

For about half of its length, the river is within the administrative boundary of the Entiat Ranger District, Wenatchee National Forest. There are two major tributaries to the Entiat River; the North Fork Entiat which joins the Entiat at river mile 33.0 and the Mad River which enters at river mile 10.5.

The subbasin is nearly 42 miles in length and varies in width from five to 14 miles. It is bounded on the northeast by the Chelan Mountains and on the southwest by the Entiat Mountains. The Chelan Mountains begin as a ridge extending eastward from the Cascade Summit near Glacier Peak. The Entiat Mountains branch off from this ridge in a southeasterly direction. The Chelan Mountains continue east a few miles then they too bend toward the southeast.

A rim of snow-covered peaks supply the Entiat's headwaters. These include Buckskin, Tinpan, and Pinnacle Mountains; Mt. Maude; Seven Fingered Jack; and Mt. Fernow. The highest elevation in the subbasin is the 9,249 foot summit of Mt. Fernow, and the lowest elevation of approximately 700 feet occurs at the confluence with the Columbia River.

Climate in the subbasin varies from arid shrub/steppe at the lowest elevations to moist alpine type at the higher elevations. Mean annual precipitation correspondingly ranges from 90 inches to less than 10 inches along the Columbia Breaks due to the rain-shadow effect of the Cascades. Most winter precipitation falls as snow; however, rain is not unusual. Average winter snowfall ranges from 50 inches at the lower elevations to nearly 400 inches on the peaks, where depths may reach 10-20 feet and remain on the ground from mid-November until June (Appendix F-9-VII).

During summer months thunderstorms frequently develop over the mountains, resulting in heavy downpours for brief periods. Occasionally, intense convective storms produce flash floods at the mouths of narrow canyons. Approximately 50 percent of the mean annual precipitation falls between October and January and 75 percent falls between October and March. The total precipitation for the two driest months, July and August, is from 5-10 percent of the annual.

During the summer, mean temperatures in the lower Entiat subbasin usually range between 60 and 70 degrees, decreasing to the 50's at higher elevations. Temperatures in the 90's frequently occur during July

and August in the lower valley. In winter, weather systems moving east from the Pacific and outbreaks of cold air from Canada produce frequent changes. During an average winter, temperatures range from 15 to 30 degrees (F) with elevation.

Mean annual runoff varies from less than five inches in the lower valley to 60 inches in the headwaters. Total mean annual runoff for the Entiat at Ardenvoir was 267,800 acre-feet (1.82 cubic feet per second per square mile; 25 inches) for the period 1957-1993. The Entiat watershed supplies water for instream, irrigation, wildlife, livestock, industrial and domestic uses. Selected discharge data for the Entiat are summarized in Appendix F-9-VII. Estimated flow data for the Entiat River indicate that a 44 percent mean annual increase in total water yield occurred from the drainage as a result of the 1970 fire (Entiat Cooperative River Basin Study, 1979).

Columbia River Tributaries

This portion of the analysis area is comprised of a number of small drainages on the Columbia River Breaks, between the Wenatchee River and Knapp Coulee. These Columbia River tributaries include Swakane Creek, Tenas George Canyon, Spencer Canyon, McKinstry Canyon, Byrd Canyon, Oklahoma Gulch, Navarre Coulee and many smaller, un-named drainages along the Breaks.

The total area included in this portion of the analysis area is 54,898 acres. A large percentage of these tributaries is in private ownership, with Federal lands occurring in the upper portion of the watershed and in scattered tracts (See Table I-1, Ownership Summary). Topography is generally very steep and dissected. Cliff and rock features are common, providing not only dramatic scenery but also unique plant and animal habitats. Vegetative cover is primarily shrub/steppe and open forest, but also includes closed forest on north slopes in stringers and in the upper reaches.

Climate in this portion of the area is as described for the lower elevations of the Entiat, with summer thunderstorms being a frequent event in these Break lands. Mean annual runoff is low, with streamflow from these tributaries being strictly intermittent.

Historical Background

This section presents a brief historical overview of human activities in the analysis area. Appendices C, F-9-IV, G-1 and H-1 provide more historical information.

Overview

The Entiat watershed has a dramatic history of disturbances, which have shaped the drainage into what it is today. These disturbances have included both human-caused and natural events, as well as many situations where the two forces have combined to create dramatic changes in the landscape (See Figure I-1).

Among the natural disturbances to affect the watershed are earthquakes. The Entiat Valley lies on an active fault system. The most notable recorded earthquake occurred in 1872, when a large rock face several miles north of the mouth of the Entiat River reportedly broke off the mountain and slid into the Columbia River, temporarily damming it. However, some recent investigations indicate that the landslide pre-dated the 1872 earthquake and that a younger slide face and talus debris may be related to the quake. Recent minor tremors have occurred in the area in 1989, 1991 and 1995.

Table I-1
Land Ownership Summary (Acres)
Entiat Analysis Area

FPU	FEDERAL*	STATE	PRIVATE	FPU TOTAL ACRES
Brennegan - Preston	7,546	---	14	7,560
Headwaters Entiat	25,590	---	---	25,590
Headwaters Mad	12,848	---	---	12,848
Lake-Silver-Pope	14,556	---	---	14,556
Lower Entiat	10,483	38	14,183	24,704
Lower Mad	14,943	219	2,833	17,995
Lower-Mid-Entiat	17,362	228	6,280	23,870
Middle Mad	10,158	468	---	10,626
Mills-Dinkleman	4,529	---	3,101	7,630
Mud	12,947	587	1,078	14,612
Navarre Coulee	7,755	---	4,188	11,943
North Fork Entiat	17,644	---	---	17,644
Ribbon Mesa	5,237	---	5,640	10,877
Roaring	9,901	691	5,706	16,298
Stormy-Potato	10,390	352	1,312	12,054
Swakane-Spencer-Tenas	15,287	3,326	13,457	32,070
Three-Tommy	12,540	---	---	12,540
Upper Entiat	17,763	---	---	17,763
Upper Mad	15,893	763	164	16,820
Upper Mid-Entiat	14,946	---	22	14,968
Analysis Area Total				322,968

* Primarily USFS with BLM tracts scattered over the eastern portion of the analysis area.

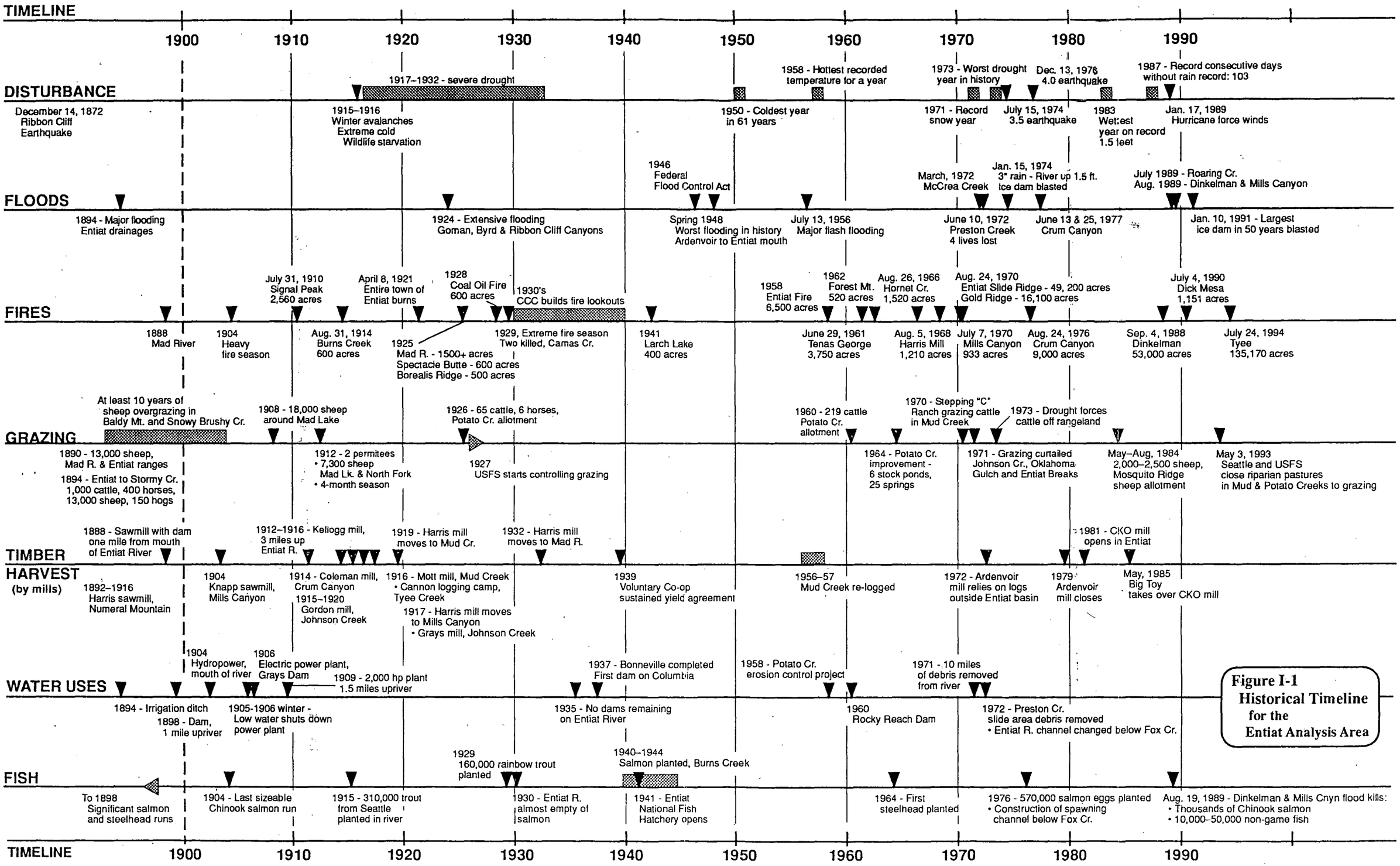
TIMELINE
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
DISTURBANCE
December 14, 1872 Ribbon Cliff Earthquake
1915–1916 Winter avalanches Extreme cold Wildlife starvation
1917–1932 - severe drought
1950 - Coldest year in 61 years
1958 - Hottest recorded temperature for a year
1971 - Record snow year
1973 - Worst drought year in history
July 15, 1974 3.5 earthquake
Dec. 13, 1976 4.0 earthquake
1983 Wettest year on record 1.5 feet
1987 - Record consecutive days without rain record: 103
Jan. 17, 1989 Hurricane force winds
FLOODS
1894 - Major flooding Entiat drainages
1924 - Extensive flooding Goman, Byrd & Ribbon Cliff Canyons
1946 Federal Flood Control Act
Spring 1948 Worst flooding in history Ardenvoir to Entiat mouth
July 13, 1956 Major flash flooding
March, 1972 McCrea Creek
Jan. 15, 1974 3" rain - River up 1.5 ft. Ice dam blasted
June 10, 1972 Preston Creek 4 lives lost
June 13 & 25, 1977 Crum Canyon
July 1989 - Roaring Cr.
Aug. 1989 - Dinkelman & Mills Canyon
Jan. 10, 1991 - Largest ice dam in 50 years blasted
FIRES
1888 Mad River
1904 Heavy fire season
July 31, 1910 Signal Peak 2,560 acres
Aug. 31, 1914 Burns Creek 600 acres
April 8, 1921 Entire town of Entiat burns
1925 Mad R. - 1500+ acres Spectacle Butte - 600 acres Borealis Ridge - 500 acres
1928 Coal Oil Fire 600 acres
1930's CCC builds fire lookouts
1929, Extreme fire season Two killed, Camas Cr.
1941 Larch Lake 400 acres
1958 Entiat Fire 6,500 acres
1962 Forest Mt. 520 acres
Aug. 26, 1966 Hornet Cr. 1,520 acres
Aug. 24, 1970 Entiat Slide Ridge - 49, 200 acres Gold Ridge - 16,100 acres
July 4, 1990 Dick Mesa 1,151 acres
June 29, 1961 Tenas George 3,750 acres
Aug. 5, 1968 Harris Mill 1,210 acres
July 7, 1970 Mills Canyon 933 acres
Aug. 24, 1976 Crum Canyon 9,000 acres
Sep. 4, 1988 Dinkelman 53,000 acres
July 24, 1994 Tyee 135,170 acres
GRAZING
At least 10 years of sheep overgrazing in Baldy Mt. and Snowy Brushy Cr.
1890 - 13,000 sheep, Mad R. & Entiat ranges
1894 - Entiat to Stormy Cr. 1,000 cattle, 400 horses, 13,000 sheep, 150 hogs
1908 - 18,000 sheep around Mad Lake
1912 - 2 permitees • 7,300 sheep Mad Lk. & North Fork • 4-month season
1926 - 65 cattle, 6 horses, Potato Cr. allotment
1927 USFS starts controlling grazing
1960 - 219 cattle Potato Cr. allotment
1964 - Potato Cr. improvement - 6 stock ponds, 25 springs
1970 - Stepping "C" Ranch grazing cattle in Mud Creek
1973 - Drought forces cattle off rangeland
1971 - Grazing curtailed Johnson Cr., Oklahoma Gulch and Entiat Breaks
May–Aug, 1984 2,000–2,500 sheep, Mosquito Ridge sheep allotment
May 3, 1993 Seattle and USFS close riparian pastures in Mud & Potato Creeks to grazing
TIMBER HARVEST (by mills)
1888 - Sawmill with dam one mile from mouth of Entiat River
1892–1916 Harris sawmill, Numeral Mountain
1904 Knapp sawmill, Mills Canyon
1912–1916 - Kellogg mill, 3 miles up Entiat R.
1914 - Coleman mill, Crum Canyon
1915–1920 Gordon mill, Johnson Creek
1916 - Mott mill, Mud Creek • Cannon logging camp, Tyee Creek
1917 - Harris mill moves to Mills Canyon • Grays mill, Johnson Creek
1919 - Harris mill moves to Mud Cr.
1932 - Harris mill moves to Mad R.
1939 Voluntary Co-op sustained yield agreement
1956–57 Mud Creek re-logged
1972 - Ardenvoir mill relies on logs outside Entiat basin
1979 Ardenvoir mill closes
1981 - CKO mill opens in Entiat
May, 1985 Big Toy takes over CKO mill
WATER USES
1894 - Irrigation ditch
1898 - Dam, 1 mile upriver
1904 Hydropower, mouth of river
1905-1906 winter - Low water shuts down power plant
1906 Electric power plant, Grays Dam
1909 - 2,000 hp plant 1.5 miles upriver
1935 - No dams remaining on Entiat River
1937 - Bonneville completed First dam on Columbia
1958 - Potato Cr. erosion control project
1960 Rocky Reach Dam
1971 - 10 miles of debris removed from river
1972 - Preston Cr. slide area debris removed • Entiat R. channel changed below Fox Cr.
FISH
To 1898 Significant salmon and steelhead runs
1904 - Last sizeable Chinook salmon run
1915 - 310,000 trout from Seattle planted in river
1929 160,000 rainbow trout planted
1930 - Entiat R. almost empty of salmon
1940–1944 Salmon planted, Burns Creek
1941 - Entiat National Fish Hatchery opens
1964 - First steelhead planted
1976 - 570,000 salmon eggs planted • Construction of spawning channel below Fox Cr.
Aug. 19, 1989 - Dinkelman & Mills Cnyn flood kills: • Thousands of Chinook salmon • 10,000–50,000 non-game fish
TIMELINE
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

Figure I-1
Historical Timeline for the Entiat Analysis Area

Severe, high-intensity thunderstorms are also a common occurrence in the watershed. As recently as 1992, a heavy thunderstorm caused sediment deposition in the Entiat River near Lake Creek. In August 1989, an intense thunderstorm resulted in flooding in Mills and Dinkleman Canyons and Roaring Creek, within the Dinkelman Fire area.

Due to its low elevation and rain-shadowed climate, the lower Entiat watershed is prone to relatively frequent fires. According to a 1987 fire scar study of the Entiat Valley, fires historically burned over a large percentage of the lower drainage every seven to ten years. The range of severity of prehistoric fires is not known. The 1888 Mad River Gorge fire, reportedly devastating, was comparable to the 1970 Fires. From 1900 up until the late 1960s, few fires grew to larger than 2,000 acres. Since 1970, the Entiat Valley has experienced six fires exceeding 2,000 acres: Gold Ridge, Shady Pass, Entiat, Crum Canyon, Dinkleman, and Tyee Fires. Collectively, these fires have burned 60 percent of the watershed.

Flooding is an event closely linked to fire in the Entiat watershed. Obviously, fire temporarily removes critical stabilizing vegetation, which promotes rapid runoff and soil movement. Compounding this impact is the fact that many soil types in the Entiat subbasin are conducive to runoff and erosion. In addition, development of hydrophobic conditions following a high-intensity fire is also a factor on many soils in the drainage.

Since 1970, flooding has followed every major fire in the drainage. The floods following these fires have been the result of localized thunderstorms. In addition, significant flooding occurred in the Entiat Valley in 1948, 1956, and 1974. This was a result of heavy spring rains, which only exacerbated the effects of spring runoff and rapid melt.

Fire suppression began to play a role about the time the National Forest was created (ca. 1907). However, the effectiveness of fire suppression did not mature until the 1930s when technology, communication, detection and manpower advances began to seriously contribute to successful suppression. The effectiveness of fire suppression has steadily increased with technological advances, better training and funding. Although it is difficult to quantify the effects fire suppression has had on the watershed, it is clear that aggressive fire suppression has allowed increased stocking in stands and a build-up of dead and down forest fuels. This situation may have contributed directly to the size and intensity of at least three of the six large fires since 1970.

Rehabilitation work following major events has also affected the watershed. Following a major flood in 1948, this work included channel modifications that dramatically changed the character of the Entiat below Brief. Large-scale, burned area rehabilitation programs also occurred subsequent to the 1970 fires, Crum Canyon, Dinkleman and Tyee Fires. Channel modifications were again made in the Entiat following the Crum Canyon floods in 1977.

Range Use History

"Grass that waved in the breeze like a wheat field;
No sagebrush and very little buckbrush (bitterbrush);
No sunflowers (balsamroot), only on the banks of the
Columbia River"

This description of the range on the Entiat District from the Columbia River to Mud Creek in 1894 was given by Ed Hedding and other long-time residents ("old timers") in the area.

Human disturbance has played a large part in changes that have occurred in the Entiat watershed. Little data are available regarding the effects of Native Americans and early settlers on the area; however, evidence suggests both Native Americans and prospectors set fires for various purposes. Early documented human

disturbances include the construction of irrigation diversion and hydroelectric dams, mills, timber harvest and road construction in the watershed, which started in the late 1800s. The first irrigation canal was built in 1894.

Settlers introduced grazing of cattle, horses and swine around 1894. The effects of grazing on watershed conditions over the following decades were dramatic. At one time, it was estimated that 1,000 head of cattle and 400 head of horses grazed the area from Entiat to Quartz (or Stormy Creek as it is now known). Additionally, 150 hogs grazed in the area almost year-round.

Sheep grazing in the area began in the 1890s. By 1900, grazing was widespread and uncontrolled; as many as 13,000 sheep were herded from the Columbia River to the head of the Entiat River. In fact, a 1902 report tells of some 60,000 sheep summering in the upper Entiat and Mad River areas; however, the true number is likely much higher, as sheep herds were often counted by the number of ewes alone. Range conditions deteriorated steadily in the early 1900s due to unregulated grazing pressure.

The Wenatchee National Forest was created in 1907. In 1920, the Entiat River drainage was transferred from the Chelan National Forest to the Wenatchee National Forest, with watershed protection as a primary management goal. As a result, restrictions on grazing began to be introduced to reduce the impacts of heavy use.

The Potato Creek Allotment was created in 1926 and included both Potato and Stormy Creeks. The Mud Creek, Crum Canyon and Moe Creek units were added as range became available. In 1971, a cooperative agreement between the Washington State Department of Game, Entiat Valley Stockmens Association and the Forest Service reduced grazing in Johnson Creek, Oklahoma Gulch and the Entiat Breaks in exchange for grazing use in the Mud Creek Stepping C area. The previous grazing ranges were critical winter range for mule deer.

Since 1976, the entire Potato Creek Allotment has been under a Rest Rotation Management System. Grazing utilization standards became more strict when the 1990 Wenatchee Forest Plan was approved and implemented. At that time, key use areas were identified and new utilization standards were implemented beginning with the 1991 grazing season, and in 1992 the intent of the Forest Plan's standards and guidelines was fully implemented.

Overutilization of the riparian areas in the Mud and Potato Creek pastures in 1992 resulted in the closure of those pastures to grazing during the summer of 1993. Only two months after the 1994 grazing season began, the Tyee Fire resulted in the closure of the entire Potato Creek Allotment. The Allotment will remain in a non-use status until the established criteria for re-entry of livestock have been met (See criteria Appendix G-4). At the present time, there are two permittees on the Potato Creek Allotment. An analysis was started in 1995 to establish temporary pasture (not to exceed five years) for some of the displaced, permitted cattle.

While sheep have been grazing in the Mosquito Ridge area since the 1890s, this Allotment was actually established for use by sheep and cattle in 1983. The entire Allotment area burned in 1970. It includes approximately 22,000 acres of forest lands from lower Moe Ridge to the Entiat Mountain summit and from Roaring Ridge to Tillicum Creek. Only a small portion of the Mosquito Ridge Allotment was affected by the Tyee Fire and it is expected that grazing use will continue.

Appendices G-1, G-5 and F-9-IV provide more information on historic range use.

Recreation Use History

The following is a brief description of the recreational activities that have evolved throughout the Entiat Valley from the early 1900s.

The first evidence of recreational hunting can be traced back to the early 1900s to 1910, when mountain goats (reportedly found as far south as Tyee Mountain) were hunted in the Entiat Mountains.

In 1909, a two-year construction project to build the Entiat River Trail began at Burns Creek. In 1916, a cabin was built at North Fork and was utilized by the Hudson Bay Trapping Company. In 1919, the Entiat River Road was extended from North Fork to Cottonwood Campground. The extension of the Road enhanced dispersed recreation and it was during this time that Silver Creek (along Entiat River) became a popular destination and camping area for weekend visitors. By 1923, the Silver Creek area was being developed as a formal recreation/camping site, and in 1925, volunteers began stocking high mountain lakes with trout.

In the early 1930s, Shetipo, Duncan Hill and Klone Peak Trails and their respective lookouts were constructed. The Tyee Lookout was built in 1932. Soon after, the public discovered these gateways into the mountains and use was established by both recreationists and hunters.

By the mid- to late 1930s, guest ranches had been established at Lucerne and in the upper Valley area. Trail crews were formed to maintain phone lines and the routes that were used to access lookouts and forest fires. Deer populations rose and hunting became more popular throughout the Valley. In fact, the Hunters Trail shelter was constructed and used as a hunters cabin. During this time, the CCC provided labor for many projects including the building of Cottonwood Guard Station, Steliko Barn and the widening of the Entiat River Road from Silver Falls to Cottonwood.

The addition of roads up to Maverick Saddle and Shady Pass in the early 1940s and the development of self-contained camp trailers in the late 1940s promoted dispersed recreation into the Valley. In 1946, a ski hill was developed near Dill Creek, which also enticed more recreationists to the area.

In the 1950s, the North Fork Road was built to facilitate logging activities in the area. During the late 1950s, motor bikes began appearing on Forest trails. In the 1970s and 1980s, motor bike trail use increased immensely. In 1990, the signing of the Forest Plan closed the North Fork of the Entiat to motorized travel. Although this regulated use was challenged in court, enforcement of the closure was instituted in 1993.

Recreational use throughout the Entiat Valley has increased with its development and the proximity of the area to large population concentrations. Societal trends have also influenced its popularity, as more individuals and families spend greater amounts of time participating in outdoor activities. Continued use is expected to increase with further development and migration of people to the area.

Natural Range of Variability

The term "natural variability" refers to the composition, structure, and dynamics of ecosystems across landscapes prior to European settlement (Swanson et al. 1994). As pointed out by Swanson et al. (1994), we have adopted the concept that managing an ecosystem within its range of natural variability is the best means of maintaining biological diversity (biodiversity). A biologically diverse ecosystem is resilient because of the variety of structures, number of species, and different successional stages present on the landscape.

Eastside forest ecosystems are inherently diverse. Inherent vegetation patterns across landscapes are determined by geomorphology, soil and microclimate, while induced diversity is influenced by fire, water, wind, animals and humans (Thomas et al. 1979, Hall 1980, Hall 1984, and Johnson and Clausnitzer 1991). The recurrence of fire is promoted by a set of environmental conditions, with lightning storms being a dominant mechanism; however, Native Americans also set many fires (Agee 1994, Johnson et al. 1994, McCleery 1994). These two ignition sources, along with fuels, weather and topography, influence fire spread and behavior, affect landscape pattern, composition and structure (Hall 1984, Agee 1994, Harrod et al. in press).

The vegetation in the Entiat Analysis Area and elsewhere on the eastside has been strongly influenced by periodic distrubance, particularily fire, in pre-settlement time (Weaver 1951, Cooper 1961, Weaver 1961, Mutch 1970, Arno 1979, Swetman and Dieterich 1983, Gast et al. 1991, Agee 1994, Johnson et al. 1994, Harrod et al. in press). Disturbances in ecosystems are important mechanisms of succession, which provide

for diversity on the landscape. In addition, native species have adapted to and, in part, evolved with natural disturbance events (Cooper 1961, Mutch 1970, Buckley 1984, Taylor and Fonda 1990, Swanson et al. 1994, Harrod et al. in press).

For example, many grasses are able to survive fire because: 1) meristematic tissue is beneath the ground; 2) only one-year's growth is consumed by fire rather than many years accumulated by woody plants; and 3) reproductive age is reached early (Cooper 1961). Ponderosa pine and mature Douglas-fir have thick fire-resistant bark. Some plants may actually have evolved to be more flammable. Increased flammability acts as an agent of interspecific competition by damaging competitors, as long as individuals of a species can tolerate or quickly regenerate after fire (Mutch 1970, Buckley 1984). So, fire is an important ecological process that, in part, creates diversity in landscapes, communities and species, and provides for resiliency and dynamism. Moreover, when disturbances within an ecosystem fall outside the range of natural variability, biodiversity is lowered and resiliency is lessened.

This assessment attempts to describe "historic" vegetation in the Entiat analysis area, prior to European influence. This description will be used for comparative purposes with the existing vegetation condition. The area has been stratified by potential vegetation, but an emphasis is placed on community structures and compositions that result from disturbance, especially fire. Plant communities with similar fire regimes and resultant landscape vegetation patterns have been consolidated into groups. Historic vegetation patterns were determined by a combination of "clues" gathered from existing vegetation, historical reports and soil characteristics.

Organization of this Document

The remainder of this document presents the Entiat Watershed Assessment according to the original eight-step process, as outlined in the Federal Agency Guide for Watershed Analysis (FEMAT).

Chapter 1 presents FEMAT Steps 1-3: Identify Issues, Describe Desired Conditions, Formulate Key Questions, Identify Processes and Functions and Conditions and Stratify the Watershed.

Chapter 2 presents FEMAT Steps 4-6: Analyze Information, Describe Past and Current Watershed Conditions, Describe Condition Trends and Predict Effects. These are the steps that module completion fulfills.

Chapter 3 presents FEMAT Step 7: Integrate, Interpret and Present Findings. This is the synthesis process.

Chapter 4 presents FEMAT Step 8: Monitoring, Information Management and Revision.

Chapter 5 provides information on management priorities for the analysis area, as recommended by the analysis team for Version 2.0.

CHAPTER 1

STEP 1: Identify Issues, Describe Desired Condition, Formulate Key Questions

This document presents the results of both the first and second iterations of the watershed assessment for the Entiat Analysis Area. The first version of this assessment (Version 1.0) was completed in February, 1995 and focused primarily on fire recovery. This second iteration of the assessment (Version 2.0) incorporates and updates Version 1.0 and addresses new issues related to recreation, commercial grazing and Columbia River Tributaries adjacent to the Entiat subbasin.

The analysis area for Version 1.0 consisted of the Entiat and Mad River **key watersheds**. The analysis area for Version 2.0, referred to as the "Entiat Analysis Area" in this document, includes the Entiat and Mad River key watersheds, adjacent lands in the Columbia River Breaks on the Entiat Ranger District and the Navarre Coulee portion of the Chelan Ranger District. Although watershed analysis is not required for management of the Columbia River Tributaries, the Wenatchee National Forest Supervisor chose to include that area in this assessment in order to maintain consistency in approach.

Issues and key questions addressed in each iteration of this analysis are described below:

Version 1.0 - Fire Recovery Emphasis

Issues: Fire recovery was the primary emphasis of the first iteration of this assessment. The Version 1.0 analysis was framed by six co-dominant issues and targeted at addressing specific questions related to these issues. This focus was necessary in order to meet the narrow timeframes associated with the site-specific analysis, design and implementation of recovery projects within the 140,000 acre Tyee Fire. This wildfire burned 88,958 acres of the Entiat watershed in July, August and September of 1994. This large burn area presents opportunities to harvest fire killed trees and move the vegetative component towards a condition that is more fire resilient and sustainable. Some of these opportunities are relatively short-term, in that many of the smaller diameter trees will only retain value supporting their removal for a year or less.

The six co-dominant issues identified by the Interdisciplinary Team (IDT) for Version 1.0 were as follows:

* Vegetative structure/condition
* Wildlife & Fish populations
* Historic events/human impacts
* Sedimentation
* Scenic quality
* Watershed improvement efforts

Key Questions: The IDT for Version 1.0 developed the following key questions to direct the analysis. These 13 questions were designed to elicit the information deemed necessary to describe the past and present conditions related to the issues.

- 1) What vegetative conditions (structure and composition) are sustainable given the natural disturbance regimes? (Include spatial arrangement, composition, standing and down, and successional stages.)

- 2) What are the stratifications of Question #1, including both riparian and upland areas?

- 3) What wildlife guilds (and populations) will be associated with the vegetation structures in Question number 1?

- 4) What are the current vegetation structures, including successional stages, with the same stratifications as Question 1?

- 5) What is the difference between the current structure and the naturally sustainable structure?

- 6) What is the current sediment yield as opposed to the sediment yield prior to settlement (prior to human activities)? Why are they different?

- 7) What are the deer numbers associated with the natural vegetation structures and use patterns?

- 8) How has the change in vegetation affected deer, and what can be done about it?

- 9) Where has human activity influenced wildlife populations in the Entiat subbasin?

- 10) Where and what type of watershed improvement should be accomplished in the Entiat over the next two years?

- 11) What is the present scenic condition and character of the watershed and what areas need scenic quality maintained, enhanced, or rehabilitated?

- 12) How do past actions or events relate to the development of current watershed conditions?

- 13) How does current aquatic habitat compare with the range of habitat conditions with which relevant aquatic species evolved?

Version 2.0 - Range and Recreation Emphasis

Issues: Range and recreation-related issues were the primary emphasis of the second iteration of this assessment. This iteration also addressed updates to the findings in Version 1.0 and inclusion of the Columbia River Tributaries described earlier. Watershed analysis of range and recreation-related issues was triggered by the need to complete site-specific analyses for both of these forest uses. Recovery of range resources in fire-affected allotments and the desire for interim temporary pasture have generated specific concerns for commercial grazing activities. Increasing recreational use in the watershed has generated increasing concern for resource damage and use conflicts, especially in the upper Entiat Valley.

Key Questions: The IDT for the second iteration developed the following key questions to direct the analysis. As in the first analysis, these questions were designed to generate the information necessary to describe the past and present conditions relative to the issues.

Effects of commercial grazing on ecosystem function:

- 1) What is the historic/current distribution of grazing?

- 2) What have been/are the effects of commercial grazing on: soil productivity, hillslope hydrology, composition and distribution of vegetation, wildlife, riparian areas, channel stability, water quality, fire intensity and recreational experiences?

- 3) How and where do grazing and other resource management goals/objectives conflict or complement one another?

Opportunities to improve ecosystem function through adjustments in commercial grazing and related watershed restoration:

- 4) What is the current and projected forage base (domestic & wildlife)?

- 5) Where is the suitable range (primary & secondary; C&H and sheep)?

- 6) Are range improvements adequate to protect other resources?

- 7) What are the needs for restoration and maintenance of riparian areas?

- 8) What are the processes for soil recovery, related timeframes and appropriate monitoring criteria?

- 9) What are appropriate re-entry criteria (post-fire) to achieve long-term vegetation goals and support commercial grazing?

- 10) What management strategies are needed to resolve conflicts between commercial grazing and other resources? (e.g., how to distribute forage between wildlife and commercial grazing)

- 11) How has wildfire affected range opportunity (e.g., Blue bunch wheatgrass conversion to cheatgrass)?

Effects of recreation activities on ecosystem function:

- 12) What is the history of recreational activities in the analysis area?

- 13) Where are the recreation resources in the analysis area? What are they?

- 14) What is the present condition of recreation facilities, especially as it effects other resources? (developed, dispersed, trails, roads)

- 15) What have been/are the effects of recreational activities on: soil productivity, hillslope hydrology, composition and distribution of vegetation,riparian areas, channel stability, water quality, and fish and wildlife populations?

- 16) What areas and resources are sensitive to recreation use?

Opportunities to improve ecosystem function through adjustments in recreation management and related watershed restoration:

- 17) What expansion opportunities exist for winter/summer recreation opportunities?

- 18) What recreation opportunities are not being provided?

- 19) What areas need the recreation resource maintained, rehabilitated or re-located?

- 20) What opportunities exist to reduce user conflicts in the upper Valley?

- 21) How and where do recreation and other resource management goals/objectives conflict or complement one another? How can we accomodate dispersed camping while protecting other resources and public health and safety?

Application of watershed analysis findings to Columbia River Tributaries:

- 22) Do the findings in Version 1.0 apply to the Columbia River Tributaries, added to the analysis area in Version 2.0?

- 23) What are the scenery resources of the Columbia River Tributaries?

  (a) Where are the areas that need the Scenic Quality maintained, enhanced, rehabilitated?
  (b) What is the present Scenic Integrity (condition) and Landscape Character of the Columbia River tributary area? What Scenic Condition and Landscape Character does the user prefer? What and where are the attractive features or places of the watershed?
  (c) What are the Landscape Character Themes for the area?
  (d) Where are the Special Places?

This Watershed Analysis meets all the requirements listed in the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (Northwest Forest Plan) and those for the PAC Fish agreement. Items not covered in this iteration of the watershed assessment are discussed in Chapter 4.

Although the total drainage area involved in this analysis is large, the analysis teams felt that addressing both fifth field watersheds (Entiat River and Mad River) at the same time would be an appropriate step from a basin-level perspective. Subsequent analysis may address these key watersheds separately if necessary. Addition of the Columbia River tributaries in this iteration helps to insure application of consistent management strategies on these lands.
This watershed analysis for Federal lands was conducted in recognition of parallel assessment work being coordinated by the Chelan County Conservation District (CCCD). The CCCD Cooperative Management Plan will focus on watershed management issues associated with the private lands in the subbasin. However, completion of the CCCD Plan will also involve a total watershed view, with cooperating agencies providing support and information from their analysis processes. This second iteration analysis of federal lands in the Entiat subbasin is being completed in concert with the CCCD cooperative planning effort.

STEP 2: Processes and Functions

In this Step, the teams felt that issue and resource boundaries dissolved. Many of the processes and functions are inter-related and are difficult to discuss in a purely functional theme. The following processes and functions are general and encompass at least some aspect of all resource areas.

Unmanaged Historic Grazing resulted in:

- altered vegetation patterns
- change in wildlife habitats & use patterns
- soil compaction
- soil erosion & loss of topsoil
- increased sediment to streams
- impacts to stream channels
- reduction in riparian shrubs
- food for people
- noxious weed spread

Fire Exclusion/Suppression results in:

- overstocking of trees
- successional advancement
- fuel accumulation
- change in wildlife habitats & use patterns
- increased potential for catastrophic events
- simplified landscape patterns
- soil moisture stress (effects on stream flow and aquifers)
- change in scenic condition

Roading/Transportation/Access results in:

- increased erosion
- increased sediment to streams
- wildlife disturbance and displacement
- invasion of weeds
- reduction in riparian vegetation (increased temperatures, decreased woody debris)
- altered wildlife habitat effectiveness
- altered water quality
- confined stream channel
- provides recreational access and opportunities and viewing opportunities
- culverts affecting fish migration
- altered hillslope hydrology

Timber Harvest results in:

- altered vegetation patterns
- altered wildlife habitats (positive/negative depending on species)
- potential increase in down fuels without treatment
- increased ladder fuels with stressed sub-canopy
- change in scenic condition
- increased soil disturbance (compaction, displacement, erosion)
- impacts to riparian areas (altered vegetation)
- altered water yield
- commodity extraction
- wood for people

Agricultural Activities result in:

- impacts to fish migration (physical barriers like dewatering)
- positive/negative impacts on wildlife depending on species
- food for people

Recreational Use results in:

- reduced wildlife habitat effectiveness
- increased wildlife disturbance & displacement
- increased soil disturbance
- impacts to riparian areas (vegetation loss, bank disturbance)
- increased fire risk (catastophic, size of fire)
- decreased fish populations
- sensory experiences
- psychological and physical well being
- noxious weed spread

Large High/Moderate Intensity Fires results in:

- threats to life and property
- altered vegetation patterns relative to species composition, structure, density, and spatial arrangement.
- altered wildlife habitats
- increased risk of flooding/debris flows
- a preponderance of early successional stage plant communities
- change in scenic condition
- altered water yield
- enormous fire suppression costs

Flooding results in:

- threats/loss to life and property
- increased surface runoff and erosion
- increased sediment and organic matter delivery and transport
- altered riparian areas and stream channels
- damage to facilities (roads, campgrounds, etc.)
- redistribution/loss of aquatic organisms

STEP 3: Stratify the Watershed

Stratification is the process of identifying like ecological areas that can be predicted to react similarily to disturbance or management actions. Stratification helps simplify field work and analysis by identifying areas that can be evaluated as uniform units. Also, patterns of landscape form and function that define sensitivity to important environmental changes can be identified.

This second analysis used the same processes and stratifications that were developed for Version 1.0. The Watershed Assessment Teams were divided into four smaller teams to address the Key Questions: Vegetation, Soil/Water/Fish, Wildlife, and Scenery (see Appendix I). The Vegetation team stratified its findings into five vegetative groups. The Soil/Water/Fish team used three landtype/sedimentation zones. The Wildlife team used a set of wildlife species guilds and the Scenery team chose not to stratify, using instead the whole drainage.

Each analysis team was responsible for addressing Key Questions related to its area of expertise. In the Version 1.0 analysis, questions were specifically assigned to each team (Vegetation-Q 1,2 &4; Wildlife-Q 3,7,8, & 9; Soil/Water/Fish-Q 6, 10 & 13; Scenery-Q 11; General-Q 5 & 12). For Version 2.0, key questions were used as general guides to the analysis. During synthesis for Version 1.0, the five vegetative groups were chosen as the common stratification for the Entiat assessment.

These vegetation "groups" were identified with similar disturbance regimes--analogous to the approach taken by Agee (1994) and in the Mission Creek Watershed Assessment (1995). The vegetation groups were delineated based on structure, physiognomy, tree species presence and tree canopy density. The groups reflected a similarity in fire frequency and, to some extent, similar fire intensities and soil characteristics as well. These groups included:

Shrub/Steppe Group - Dry plant communities dominated by shrubs, grasses, or both. Tree canopy cover is less than 10 percent and trees are ponderosa pine or sometimes Douglas-fir. Common and dominant shrubs are bitterbrush and sagebrush. Common grasses are bluebunch wheatgrass, junegrass, Sandberg's bluegrass, and bottlebrush squirreltail. In the Entiat, this group is found below the Forest margin or on drier sites within the forested areas. Elevations less than 4,500 feet.

Open Forest Group - Open forest communities, mostly at lower elevations on relatively dry sites, commonly with grass or shrub understories similar to the Shrub/Steppe Group and tree canopy covers of 10-50 percent and grass/shrub cover of 10-90 percent. Ponderosa pine and Douglas-fir are the dominant trees, with grand-fir on some sites. These stands are essentially a transition between the shrub/steppe below and the closed forest above. Elevations less than 4,500 feet.

Closed Forest Group - Closed forest communities with tree canopy covers of over 50 percent with various understory species. Typical elevation ranges are between 1,500 and 4,500 feet. May occur on north slopes at lower elevations and southerly aspects in the subalpine zone. Climax tree species are either Douglas-fir or grand fir. Ponderosa pine and to a lesser extent lodgepole pine are seral tree dominants. This group combines fairly dry stands with relatively low site productivity and moist closed forest stands with fairly high site productivity. Fire-return intervals are somewhat longer in the moist end of this group.

Closed Subalpine Group - Closed subalpine forest communities with more than 50 percent tree canopy cover and various understory species. Typical elevations for this type are between about 4,500-6,000 feet. This group can be found at lower elevations in cold air drainage areas and on north slopes. The predominant climax tree species in this group in the Entiat is subalpine fir and lodgepole pine is the typical seral tree stand dominant.

Open Subalpine/Alpine Group - Open forest/park land interspersed with subalpine and alpine meadows typify this group. Stands do not close over (canopy <50 percent) except in small clumps and understory composition is commonly low shrubs, forbs, and graminoids. Conditions are often cold and snowy at the typical elevational range of this group (4,500-7,500 feet, with most over 6,000 feet). Common trees are subalpine fir, Englemann spruce, whitebark pine, and subalpine larch. Mountain hemlock may be present, but has limited distribution in the Entiat. Open forest and non-forest over 4,500 feet went into this group.

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CHAPTER 2

STEPS 4-6 Analyze Information, Describe Past and Current Watershed Conditions, Describe Condition Trends and Predicts Effects.

Analysis Modules Completed for the Entiat Analysis Area

In both iterations of this assessment, four basic analysis modules were chosen to address the issues and key questions: **Vegetation, Wildlife, Soil/Water/Fish and Scenery.** Modules are a set of guidelines and instructions on how to proceed with a watershed level assessment and provide the scientific basis for addressing the key questions. Appendix I contains a list of the individuals involved with each module, as well as support and other agency personnel who participated in the analyses.

Analysis Module Summaries

Following is a brief summary of the findings from each of the four analysis modules. These summaries provide the "cumulative" findings resulting from both the first and second iterations of this watershed assessment. Also included in this section are descriptions of current recreation and range use conditions in the analysis area. **The complete text for each of these analyses is in the appendices.**

VEGETATION

Vegetation types were delineated, based upon attributes that could be mapped using PMR (Pacific Meridian Resource) satellite mapping, into five groups: shrub/steppe, open forest, closed forest, closed subalpine forest and open subalpine forest/parkland-alpine meadows. Existing and historic conditions for each of these groups were described. Both weedy exotic plants and rare plants were also discussed. Riparian vegetation occurs throughout the analysis area and was discussed on a landscape basis rather than within each vegetation group. See Appendix E for a complete text of the vegetation analysis.

Vegetation is a key component of nearly all ecosystems. The spatial arrangement of different types of stands on the landscape, the structural attributes of those stands and the kinds and amounts of plants that are currently present and the potential vegetative compositions over time are all characteristics of the Analysis Area. These characteristics influence, among other things, wildlife habitat, biological diversity, disturbance patterns/types, soil chemistry and development, soil erosion, sedimentation and streamflow regimes. Understanding the vegetation in the Entiat analysis area is a key to understanding the inter-relationships of many other landscape components.

Vegetative conditions in the Entiat were addressed in three temporal settings: current; pre-settlement; and pre-Dinkelman and Tyee Fires (1988 & 1994, respectively). The historic range of conditions was postulated and compared to the more recent vegetative conditions. Aerial photo interpretation, satellite imagery, ecology plot data, maps of vegetative types and local knowledge were used to map current vegetative conditions and infer other stand and landscape attributes. The natural range of variability of the vegetative types was determined by using professional judgement to extrapolate data from current vegetative conditions, historic documents and published literature.

Current vegetative structures and spatial patterns and, consequently, the ecosystem processes and functions, varied from quite similar to quite different from the postulated historic conditions. The closed subalpine

and open subalpine forest/parkland-meadows are really not too different from the pre-settlement stands. The shrub/steppe (pre-fire) supported more of a shrub canopy than in presettlement times. The two major shrub species (bitterbrush and sagebrush) were kept at low levels, historically, by frequent fire. Fire suppression has allowed these two shrub species, in particular, to increase today. The open forest group probably had a higher-than-historic tree mortality rate from the recent fires and currently supports fewer trees. Prior to the recent fires, these stands were starting to develop a cohort of smaller trees that was not typical of the historic conditions.

The closed forest group, however, appears quite different from what would have occurred in pre-settlement times. Fire maintained more open, park-like forest communities in most of what was, until recently, the closed, mid-elevation forest areas in the Entiat. These areas seldom experienced large scale stand-replacement fires. However, the large fires of recent years (going back to 1970) have often been catastrophic in nature and have consequently killed most trees and some understory plants as well. Historically, these stands were open and park-like with large, widely-scattered, fire-resistant trees. Now, many of these stands are essentially devoid of any living trees and intense soil heating may have altered succession for many years from historical post-fire succession.

Successionally all groups, except the closed forest group, are quite similar to their historic successional conditions. In the closed forest group, however, the high fire intensity of the recent fires has set back secondary succession to its starting point. Historically, most stands in this group were maintained in mid-successional stages. After fire, most are in early succession and patch sizes are very large. Currently, there is a tremendous number of standing dead trees with few green. Historically, there were park-like stands of green trees with scattered occasional snags and logs. There are few down logs now and the mean size of all material is smaller.

In unburned stands, the main deviation from the predicted historic conditions again occurs in the closed forest group. Here, the fire-maintained conditions of open park-like stands have been replaced by large numbers of smaller, more shade tolerant trees, establishing beneath the relic, park-like stands.

Sustainability of green, closed forest group compostion and structure is in question. There are concerns that the high fuel load present on the landscape (particularly in all closed forest stands) will lead to other catastrophic fires in the future. Further, unburned closed forest conditions also point to the likelihood of an intense fire. In these areas not historically prone to catastrophic fire, some form of fuel reduction is necessary to allow succession to proceed and stands to develop as they once did. Further, overstocking and transition of some stands to true firs predisposes many stands to a greater-than-historic level of insect and disease mortality. A potential need exists for a strategy to address maintenance of these stands and reduce the high intensity fire hazard ("Dry Site Strategy").

Plant Species of Concern

This discussion includes exotic plants, noxious weeds and rare plants (Appendix E-2). Exotic plants are a concern because of their potential ability to invade sites and outcompete native species. Rare plants are a concern because of their limited population numbers and our limited knowledge makes it difficult to assess the potential for these plants to be threatened by various perturbations.

Exotic plants are a problem in the Entiat analysis area. These alien weeds are displacing native plants and communities and include such species as: *Bromus tectorum* (cheatgrass), *Centaurea diffusa* (diffuse knapweed), *Chrysanthemum leucanthimum* (oxeye daisy) and *Linaria dalmatica* (dalmation toadflax). Historically, these plants were not found in the analysis area, being relatively recent immigrants.

A number of sensitive plants are known to exist in the Entiat analysis area including *Iliamna longisepala* (long-sepaled globemallow), *Hackelia hispida* var. *disjunct* (rough stickseed, *Astragalus arrectus* (Palouse milkvetch), and *Carex buxbaumii* (Buxbaum's sedge). Two federal candidate plants are also present: *Trifolium thompsonii* (Thompson's clover) and *Petrophyton cinerascens* (Chelan rockmat). Additionally, it is possible

that a number of sensitive plants are also present in the subbasin (See list Appendix E-2.1). The historical status of all the rare plants is unknown and difficult to predict.

Relatively little of the total analysis area has been surveyed for rare plants and although some weed surveys have been done, they are not complete. Consequently, any proposed activity in the analysis area will need to address the potential impacts on both the exotic weedy plants and the rare plants on a case-by-case and site-specific basis.

WILDLIFE

Appendix A contains the complete writeups on selected habitats and species for this analysis. Following is a general description of the analysis used and tables quantifying results for the Entiat analysis area. Refer to the wildlife list in the follow-up section of Chapter 4 for information on the analyses and inventories needed to carry on with this work.

Watershed assessments have the objective of identifying resources and concerns specific to a given area, such as fragmentation of populations, identification of barriers to dispersal, increasing species understanding, gaining specific management information, defining the desired future habitat condition, and listing strategies that help achieve the desired future condition. The Entiat watershed assessment incorporates the goals and objectives of other levels of analysis (e.g., NW Forest Plan, WNF Forest Plan) so that information will be available on potential effects, and informed decisions can be made during the NEPA process.

Functions:

To maintain viable populations and meet human demands, it is necessary to understand the function of wildlife. In general, animals function as agents of movement and change through the following examples, which are recognized or accepted.

1. Maintain insect populations at endemic levels.
2. Spread the reproductive and vegetative parts of plants to new sites.
3. Reduce or increase the reproductive and vegetative potential of plants.
4. Provide food for other wildlife and plant species.
5. Aerate and disturb soil.
6. Alter water distribution.
7. Redistribute nutrients from one point to another.
8. Provide recreation and viewing opportunities for humans.
9. Provide food for humans

Population Threats:

Animal populations generally change in reaction to habitat alterations. When wildlife populations increase or decrease, other populations of plants and animals will increase or decrease as a reaction. Usually it takes a number of changes in habitat, over a large part of the species range, to threaten extinction of a population. The region has seen many types of habitat threats over large areas in the last 100 years. As a result, many species now have low populations that continue to decline.

Some potential threats to populations are as follows:

1. Habitats change constantly due to climate and natural succession from year to year and from season to season.

2. Habitat is changed for long periods of time when it is converted by construction of buildings, roads, trails, campgrounds, timber harvest, mining, dams, grazing, or fires. These changes may be rapid, but usually occur over relatively small areas. However, their effects are cumulative.
3. Habitats change because natural processes such as climate change, or environmental processes may not be occuring normally (e.g., suppression-influenced fire regime).
4. Habitats change due to catastrophic events such as severe floods, tornados, hurricanes, earthquakes, large wildfires or volcanos.
5. Habitats change as site conditions change over time and in response to natural disturbance events or succession.
6. Predation patterns change as predators learn and become more efficient, or as prey populations change.
7. Species distributions change due to changes in populations of other species of plants and animals.

Animal populations are constantly changing to fit the existing conditions. Virtually any change will affect the population of some species or group of species. The many inter-relationships between animal populations and between animals and their environments add complexity to the assessment of consequences of management activities.

Groupings of Wildlife:

Due to the complexity of wildlife management, several ways of grouping animals have been developed. The groupings that will be used in this analysis are:

a. **Plant Communities and Structural Stages** - This is a grouping of species and structural stages to simplify understanding of the province or watershed landscapes (Identification of Habitats-Wenatchee National Forest WNF).

b. **Created, Special and Unique Habitats** - This is a grouping of species that occurs in a habitat that is limited (Identification of Habitats-WNF).

c. **Critical Habitat** - Specific areas of habitat managed for a species because it is essential to their conservation; defined by the Endangered Species Act and described in the Federal Register.

d. **Threatened and Endangered Species** - These species, according to the Endangered Species Act, have low populations, a decreasing trend and are threatened by a continual population decline that may result in extinction. They are managed to ensure the continued existence of each species and effects of any actions that may affect them or their habitats must be determined through consultation with the U.S. Fish and Wildlife Service.

e. **Sensitive Species** - These species are managed to prevent their low populations from declining any further so they are not listed as "Threatened or Endangered" (Wenatchee National Forest Threatened, Endanagered and Sensitive Species List). These species have low populations over a large part of their range, populations are declining, and it appears there are continual threats to their populations.

f. **Management Indicator Species** - Species, selected in the WNF Forest Plan, whose population parameters appear to show the effects of land management on specific types of wildlife habitat.

g. **Survey and Manage Species** - Species for which habitat sufficient to maintain viable populations may not remain under management prescribed in the Northwest Forest Plan without special mitigating measures. These species are identified in the ROD for the Northwest Forest Plan.

For the Entiat watershed analysis, all of the above methods of grouping animal species are used to simplify management of the 423 wildlife species on the Wenatchee National Forest and to refine this to 50-60 species or habitats. There is overlap between the above groupings and invertebrates are not included in this list.

The following tables show estimates of the acres of habitat for species within the Entiat analysis area. The data in these tables were used to develop the desired ecological condition statements for wildlife, which are shown in Tables 3.2 through 3.7 in Chapter 3. Refer to Appendix A-1 for definitions and supporting narrative.

The habitat trends reflected in these tables are reliable; however, the actual number of acres of some habitats may vary since tabular data were obtained from a preliminary data base. Some species are listed showing a reduced habitat. Habitat data for several species was undetermined due to the lack of inventory information and the timeframes for this analysis. Most importantly, province level planning has not been completed for the wildlife resource; therefore, the requirements for many species are unclear.

Table 2.1
Plant Communities

Habitat/Structure **	Pre-1986 Acres	Post-Fire 1995 Acres	Historic Condition Acres
Shrub/Steppe	73,647	73,647	>73,647*
Open Forest	56,012	56,012	>64,774*
Total Winter range	**129,659**	**129,659**	**>138,421**
Low Elevation/Early **	6,346	47,719	11,000
Low Elevation/Mid **	68,838	42,930	16,000
Low Elevation/Late **	39,328	23,863	87,512
Total Low Elevation	**114,512**	**114,512**	**114,512**
Mixed Conifer/Early	1,591	10,439	14,700
Mixed Conifer/Mid	37,804	31,503	14,700
Mixed Conifer/Late	21,282	18,735	31,277
Total Mixed Conifer	**60,677**	**60,677**	**60,677**
High Elevation/Early	3,959	5,195	24,327
High Elevation/Mid	49,397	49,243	24,327
High Elevation/Late	20,626	18,544	24,328
Total High Elevation	**72,982**	**72,982**	**72,982**
Riparian/Early	500	10,000	5,000
Riparian/Mid	20,000	15,000	5,000
Riparian/Late	31,825	27,325	42,325
Riparian/Total	**52,325**	**52,325**	**52,325**

* Open forest moves between Shrub/Steppe to Open Forest. Low Elevation Forest moves between Open Forest and Low Elevation Forest.

** In this table, Early, Mid and Late refer to habitat structure--not vegetative succession or seral stage.

Table 2.2
Special, Unique and Created Habitats

Special, Unique and Created Habitats	Current Acres	Historic Acres
Wetlands	*	*
Springs/Guzzlers/Seeps/Wallows	*	*
Water Surface	58	>58
Meadows	1,259	>1,259
Caves/Tunnels	*	*
Rocky Terrain	25,054	25,254
Beach/Mud Flats/Gravel Bars*	*	
Non Riparian Decidous	0	>0
Other Structures	*	*
Manmade Structures	>1	0

* - Value undetermined as of the date of this analysis.

Table 2.3
Habitat for Threatened and Endangered Species

Species/Habitat	Pre-1994 Fire Acres	Post-1994 Fire Acres	Historic Acres
Northern Spotted owl	19,145	9,500	3,000
Bald Eagle Nesting	*	*	10,000
Bald Eagle Feeding	100,000	150,000	100,000
Peregrine Falcon Nesting	*	*	*
Peregrine Falcon Feeding	100,000	150,000	100,000
Gray Wolf Available	185,000	185,000	235,000
Grizzly Bear Available	135,000	135,000	235,000

Table 2.4
Sensitive Species Habitat

Species/Habitat	Pre-1994 Fire Acres	Post-1994 Fire Acres	Historic Acres
California Wolverine	73,000	73,000	73,000
North American Lynx	10,000	15,000	73,000
Pacific Fisher	24,000	10,500	65,000
Townsend's Big-Eared Bat	*	*	*
Spotted Bat	*	*	*
Bighorn Sheep	<131,000	<131,000	131,000
Northwestern Pond Turtle	*	*	*
Spotted Frog	*	*	*
Northern Red-Legged Frog	*	*	*
Cascades Frog	*	*	*
Larch Mountain Salamander	*	*	*
Harlequin Duck	<58	<58	<58
White-headed Woodpecker	39,000	24,000	87,000
Northern Goshawk	80,000	59,000	142,000
Flamulated Owl	39,000	23,000	87,000
Col. Sharp-tailed Grouse	<10,000	<30,000	<40,000
Western Sage Grouse	<10,000	<30,000	<40,000
Mountain Quail	5,500	15,000	3,500
Loggerhead Shrike	*	0	1,000
Black Tern	1,315	1,315	>1,315
Upland Sandpiper	*	*	*
Ferruginous Hawk	131,000	131,000	131,000
Bull Trout	50 miles	50 miles	50 miles

* - Value undetermined as of the date of this analysis.

Table 2.5
Indicator Species Habitat

Species/Habitat	Pre-1994 Fire Acres	Post-1994 Fire Acres	Historic Acres
Pileated Woodpecker	60,000	41,000	108,000
Marten	61,000	46,000	95,000
Northern 3-Toed Woodpecker	10,000	100,000	50,000
Mountain Goat	35,000	35,000	40,000
Mule Deer Winter Range	<129,659	<129,659	>129,659
Primary Cavity Excavators	170,000*	160,000*	196,000*
Beaver/Ruffed Grouse	32,000	27,000	52,000

* - Value undetermined as of the date of this analysis.

SOIL/WATER/FISH

The following is a summary of the analysis used to address questions related to soil/water/fish resources. The complete text of the soil/water/fish analysis is in Appendix F.

Overview

The analysis of watershed and fish resources in Version 1.0 was driven by three key issues: sedimentation, the prioritization of watershed rehabilitation and aquatic habitat simplification (Key Questions 6, 10 and 13). This second iteration (Version 2.0) was focused on: (a) analysis of the effects of commercial grazing and recreational activities on ecosystem function, (b) opportunities to improve ecosystem function through adjustments in these two resource uses, (c) incorporation of the Columbia River Tributaries into the Entiat watershed assessment and (d) refinements to Version 1.0. The desired goal is for the Entiat Analysis Area to be in a state of dynamic equilibrium such that hillslopes, riparian zones and stream channels function properly, are stable and are resilient to a range of natural events, providing habitat for all life stages of native aquatic and riparian-dependent species. **The Entiat and Mad Rivers are Tier 1 Key Watersheds, which are designated to contribute directly to the conservation of at-risk fish species.**

Key processes and conditions influencing this desired outcome are largely controlled by landtype characteristics which influence: erosion and sedimentation, soil productivity, soil moisture stress, hydrologic properties and riparian area/stream channel function. Soils in the Entiat are generally highly erodible due to widespread deposits of volcanic ash and pumice or loess at the surface. Sediment delivery rates are typically high, primarily as a function of steep slope gradient and high stream densities. Flooding and debris flows are significant transport processes for both sediment and organic material.

Management disturbances such as grazing, tractor yarding and roading generally accelerate the natural erosion and sediment delivery hazards of these sensitive soils. Soil productivity alterations resulting from the effects of overgrazing and logging and combined with fire suppression have resulted in a reduction of historic open park-like stands having dense, grassy understories. Climatic condition and coarse-textured sub-soils create conditions that limit available soil moisture for vegetative growth, once fine-textured soils at the surface are disturbed. Natural events and human activities have detrimentally-altered riparian and stream channel function, especially in the eastern half of the Entiat subbasin. Human responses to some of these events have resulted in additional detrimental impacts on ecosystem function (e.g., 1948 flood repair work simplified aquatic habitat in the lower Entiat River). Appendix F-9-VII discusses streamflows and channel structure in the context of existing conditions.

Salmonid population trends for the Entiat/Mad subbasin are variable but mostly in a long-term decline:

* Spring chinook spawning reached a thirty-three year low in 1995 with only a single redd located in the seven-mile index reach.

* Late-run chinook spawning appeared to have increased over the previous several years with 33 redds in the 12 mile spawning reach. Prior to 1994, late-run chinook spawning surveys were sporadic and incomplete.

* Sockeye spawning appeared to be nonexistent in 1995 compared to several hundred spawners in 1993. Sockeye are considered to be introduced into the subbasin. Sockeye spawning is monitored only incidentally during chinook spawning surveys and only recently (since 1992).

* Summer steelhead spawning is difficult to monitor; therefore, only estimates of natural production have been made by WDF et al. (1990). The estimated return of 140 natural summer steelhead is probably high and only a fraction of turn-of-the-century steelhead returns to the subbasin.

* Bull trout spawning in 1995 was at the seven-year average of 16 redds in the 7.7-mile Mad River index reach. This is considered to be stable but reduced from historic.

* Other salmonids (rainbow and cutthroat trout) are only incidentally monitored. No long-term population data exist; however, anecdotal evidence indicates that their distributions have been expanded by stocking and their populations have been reduced by recreational angling.

The Entiat River is identified as an impaired water body on Washington State's 303(d) list. Both temperature and pH are a concern, based on data available from the Department of Ecology's (DOE) ambient monitoring program. Supplemental data also indicate that temperature standards are being exceeded for a period of time in the Lower Mad River. No studies have been completed to date to determine the specific source or cause of these excursions beyond water quality criteria.

Analysis Zones

Analysis elements were identified to characterize sub-watersheds and evaluate ecosystem condition. Of these elements, landtype association and percent fine sediment in substrate gravels were used to stratify the analysis area into three analysis zones: **Transport, Transitional & Depositional.** Figure 2.1 displays a longitudinal profile of the Entiat River with related information by zone. Refer to Appendix F-6 for detailed information.

Transport Zone: The upper Entiat watershed (**Closed & Open Subalpine**) is a zone of strongly-glaciated landtypes. This zone has high subsurface water storage capacity favorable for vegetative growth and regulated baseflows. Coarse and fine sediment and large woody debris are recruited by a naturally high occurrence of debris flows. Fine sediment (diameter less than 1 mm) is transported through this system with minimal deposition. Historical and current management influences are primarily: localized compaction from sheep grazing and trailing; fire exclusion; dispersed and developed recreation; and timber harvest in the lower portion of the zone. Road densities (less than 1.0 mile per square mile) and riparian road densities (less than 0.1 mile per square mile) are low. Trail densities of 1.2 miles per square mile are the highest of all three analysis zones. With the exception of dispersed recreation and trails, the effects of management influences in this zone have been relatively minor. Impacts of developed campgrounds in riparian areas are minimal except at the Cottonwood facility.

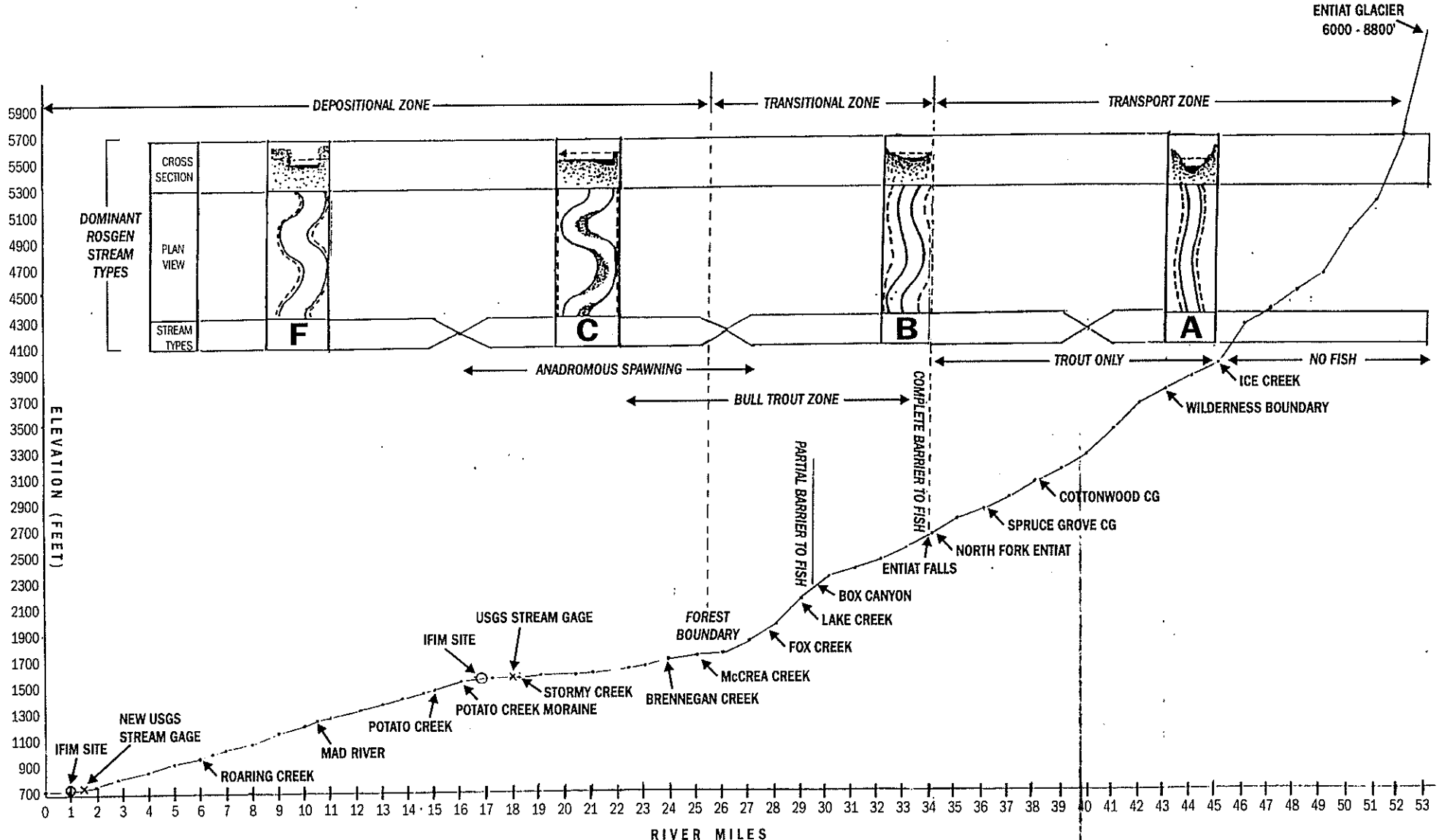

Figure 2.1. Relationship of Entiat River analysis zones, dominant channel types (Rosgen), channel gradients, fish use, and major landmarks.

The current condition of aquatic habitat in the transport zone is stable and assumed to be similar to historic, with unembedded cobble/gravel streams and the number of large pools similar to or higher than those observed in the 1930's. Habitat diversity is provided by side channels, boulders and large woody debris. This good to excellent quality habitat is occupied by resident fish, including Eastern brook trout in the upper Entiat. Anadromous fish are absent from this zone due to natural barrier falls. All nine of the major lakes of the Entiat subbasin are found here. These recreational attractions have helped spawn the 162.7 miles of trails in this analysis zone. The Washington Department of Fish and Wildlife stocks resident fish annually.

Transitional Zone: The mid-Entiat watershed (**Closed Forest & Closed Subalpine**) is an area of glacially-influenced mountain slopes without the strong expression of glacial trough valleys. Transport and deposition of fine sediment varies ~~mainly with slope and channel gradient within~~ this zone with neither process being dominant. Fine sediment (13 percent fines less than 1 mm in 1995) in the Entiat River is the lowest of all three zones. Historical and current management influences have been significant and include: localized compaction from sheep grazing and trailing; fire; fire exclusion; timber salvage/road building from the early 1970's to the present; and recreation. A portion of this zone has recently been impacted by a large, moderate-high intensity fire. Road densities (less than 2.5 miles per square mile average, except 6.6 in Brennegan-Preston FPU) and riparian road densities (less than 0.5 miles per square mile, except 1.1 in Brennegan-Preston FPU) are moderately high. Trail densities are low at 0.66 miles per square mile.

The current condition of aquatic habitat in the transitional zone has been modified from historic, with a 30-60 percent loss of pools in the mainstem Entiat, and, conversely, recovery of pool habitat in the Mad River since the 1930's stream survey. Pool habitat and large woody debris rank highest of the three zones. The trend in habitat conditions (sediment, pools, and large woody debris) is variable and uncertain. Some channel reaches have been locally impacted by timber harvest in tributaries and at road crossings. The fair to excellent quality habitat in this zone is utilized primarily by bull trout and other resident fishes, with spring chinook and summer steelhead limited to the lower reaches by natural barrier falls.

Depositional Zone: The lower Entiat (**Shrub/Steppe & Open Forest**) is an area of non-glaciated mountain slopes dissected by stream downcutting. Sediment deposition is a dominant process. Periodic floods generated from high intensity, convective storms are a significant transport mechanism. Fine sediments from steep hillslopes, swales and high gradient channel reaches are transported by surface erosion and debris flows and deposited along floodplains and alluvial fans during these events. A cycle of fill and scour occurs naturally along low gradient reaches within this landtype.

Historic and current management influences are primarily: fire; extensive grazing by sheep, cattle and horses; aggressive fire suppression; logging and road construction; domestic/agricultural development; and extensive riparian/channel alterations from roading, development and fire/flood rehabilitation. Erosion and compaction of surface soils have reduced soil moisture capacity and productivity in many areas. The percent area of open, park-like stands in this moisture-limited zone has been reduced over time by tree encroachment, as a result of fire suppression and soil productivity losses from grazing.

Both road densities (3.5 miles per square mile average) and riparian road densities (greater than 0.6 miles per square mile) are the highest of all three zones. Trail densities of 0.08 miles per square mile are the lowest of all three analysis zones. A significant portion of this zone has recently been impacted by a large, moderate-high intensity fire, posing a high risk for damage from flooding. Elimination of beaver, removal of large woody debris, riparian alterations and changes in upslope vegetation may have contributed to water table adjustments, intermittent flow regimes and alteration of riparian vegetation in some tributaries during the current droughty period.

The current condition of aquatic habitat in the depositional zone is fair to poor. Large woody debris and pool habitat rank lowest of the three zones. Pool habitat has been reduced by 90 percent in the lower-mid Entiat since the 1930's survey. The trend in habitat conditions is variable and uncertain, partially due to the frequency and extent of recent (1970 to 1994) wildfires. Percent fine sediment in the lower mid-Entiat (21 percent fines less than 1.0mm diameter in 1995) and lower Mad River (19 percent fines less than 1.0mm diameter in 1995) are highest of all three zones but considered to have improved since the excessive fine sediment input of the post-fire floods of 1972 and 1974. Many stream reaches have been artificially constrained and simplified, especially in the mainstem Entiat downstream from the National Forest. Riparian function as a sediment buffer is poor in many areas. This zone contains the principal spawning/rearing habitat for anadromous fishes in the Entiat subbasin. Most (90 percent) of anadromous spawning/rearing habitat lies outside the Forest boundary, on private land. The zone is utilized by spring chinook, late-run chinook, sockeye, summer steelhead, bull trout and other resident species.

SCENERY

The Scenery Resource analysis was driven by scenic condition, character, and where scenery is to be maintained, enhanced, or rehabilitated. The desired goal is to have a natural-appearing landscape in all ecotypes. The complete text of the scenery analysis is in Appendix D.

This process involved the analysis of viewsheds and travel routes to determine where the landscape was natural appearing or altered. Identification of scenery attractiveness, special places of concern, and the scenic character and condition of the scenery were identified, as well as the character and condition changes resulting from the Tyee Fire. Areas of high, moderate, and low burn intensities and unburned areas were described and identified within the burn perimeter. Maps available to illustrate this analysis are identified in the map source list (Page vii).

The historic and current scenic conditions and characters were evaluated with the vegetation groups inventory. These data provided the background for determining the desired scenic condition and character. The result was the chart entitled, "Ecosystem Management Options by Zones for Scenic Resource" found in Appendix D-2-VI.

The vegetation groups are further stratified into climax zones to be used towards management of a sustainable scenic landscape. The landscape qualities are a diverse composition of all plants, with a variety of all age classes that are possible to achieve.

The findings resulting from the analysis were a variety of management directions for the watershed and varied from Preservation Visual Quality Objective to Modification. The character and condition of the scenery resource were either natural appearing or altered by past management activities. The burned landscape of 1994 is a scenic character change. The condition changes in the burned area magnify the visibility of existing roads and structures.

The perception of a natural-appearing landscape is not intended to mean the same as a natural ecosystem. Natural-appearing landscapes are more desirable than altered landscapes.

The Entiat Valley Road has evolved from a natural area to a more pastoral, highly-developed rural setting. Even though the area has grown, the quality of the Entiat Valley is the quietness and less-crowded places that are connected by travel routes, such as Shady Pass, Silver Falls, and the Sugarloaf area. The travel routes, viewsheds (foreground and middleground), and special places have high scenic quality and attractiveness. These areas require that the natural-appearing character and condition be maintained, enhanced, or rehabilitated. Additionally, Potato Creek Road 5380 and Tyee Road 5700 need higher scenic management objectives of Partial Retention foreground.

Columbia River Tributaries

The Columbia Breaks portion of the analysis area is significant as a scenic backdrop setting for U.S. Highway 97 and 97A (U.S. Highway 2), and Highway 971 and for the rural communities and summer homes along the Columbia River. The backdrop is steep dissected slopes with a variety of natural-appearing vegetative patterns that range from sparse to moderately dense coniferous forest throughout. The tributaries have high-density vegetation patterns.

U.S. Highway 97 and Highway 971 represent a segment of the Cascade Loop Tour, which has international appeal. A future destination area is the Columbia Breaks Interpretive Center located in Entiat. This will focus on the Columbia Breaks country setting.

Presently, the travel routes that view into the Wenatchee National Forest lands are designated to EW-1 Modification VQO. The viewshed requires a higher scenic quality objective due to the importance of scenic travel. Future plans in the EW-1 areas are recommended to pursue the scenic quality objective of Retention foreground and Partial Retention middleground to maintain the scenic integrity of the area. In the past, maintaining High scenic quality has been compatible with the Key Deer and Elk Habitat (EW-1). Maintaining a higher scenic quality than Modification is recommended for the other secondary travel routes along the foreground, similar to Johnson Creek Road 2729.

FIRE HISTORY

Wildfire is a natural ecological process and has played a major role in shaping landscape patterns and forest succession through out the Entiat River drainage (Table 2.6). Fire suppression has increased the occurrence of shade-tolerant conifers in the ponderosa pine and mixed forests of the lower Entiat Valley, where frequent low intensity fires were relatively common historically (Barnes, 1987) (Norris, 1990).

Fire regime is a general description of the role fire plays in the ecosystem. Regimes are similar in terms of frequency, severity, moisture levels and ignition patterns (Agee 1993). The following fire frequency and severity descriptions will be used to describe the fire regimes in the Entiat analysis area. Additional information on the fire/fuels analysis is in Appendix B.

High Severity - Fires are very infrequent (greater than 100 years), high intensity and stand replacing. This regime is usually moist and cool with the larger fires occurring during periods of drought accompanied by high wind speeds. These areas generally occur above 5000 feet in moist cold regions.
Approximately nine percent of the Entiat analysis area is within this fire regime, primarily in the Closed and Open Sub-alpine vegetation zones.

Moderate Severity - Fires are infrequent (25-100 years), partial stand replacing with both areas of low and high severity. Fires usually occur during the dry summer season. Periods of high, low and moderate intensity fire behavior are mixed depending on the variability of weather conditions. Approximately 41 percent of the Entiat analysis area is within this fire regime, primarily in the Closed Mixed Conifer vegetation zone.

Low Severity - Fires are frequent (1-25 years), widespread, not stand replacing and low in intensity with few overstory effects. Frequent fires limit the time fuel can accumulate, resulting in lower intensities. These areas are in locations where nearly continuous summer, drought-like conditions exist. Approximately 49 percent of the Entiat analysis area is within this fire regime, primarily in the Shrub/Steppe and Dry Open vegetation zones.

Table 2.6
Fire Type and Results - Entiat Analysis Area

Vegetation Zone	Natural Fire Frequency	Natural Fire Type	Natural Fire Result	Result of Fire Exclusion
Shrub/Steppe	7-10 years (Barnes, 1987)	Low-intensity burns through grass shrubs and fine fuels.	Relatively few low to mid-level bitterbrush and sagebrush. Predominantly bunch grasses. Increased forage production.	Moderate to high level shrubs, loss of forage, higher intensity burns.
Open Forest	7-10 years (Barnes, 1987), 1-25 years (Agee, 1990)	Low-intensity underburns through fine fuels.	Park-like appearance with mature ponderosa pine overstory.	Multi-story canopy vulnerable to fire and insects; Moderate- to high-intensity burns.
Closed Forest	15-25 years (Agee, 1990)	Low- to moderate-intensity underburns.	Park-like appearance with mature ponderosa pine and Douglas-fir overstory.	Multi-story canopy vulnerable to insects and disease, grand fir dominates understory on moist sites; High-intensity burns.
Closed Subalpine	100-150 years (Agee, 1990)	Stand-replacing fires of moderate to high intensity.	Lodgepole often dominates sites in early and mid-successional stages. Stand-replacing fires often occur before subalpine fir becomes dominant.	Stands advance toward late succesional with subalpine fir dominating all canopy levels.
Open Subalpine	300 years (Agee, 1990)	Most fires are smoldering "cigarette" burns, high-intensity fires at 300-year intervals are stand replacing.	Mosaic of meadows and subalpine fir or whitebark pine clumps.	May reduce early successional species such as whitebark pine.

Past and Current Conditions

Fire history of the Entiat analysis area was determined from District and Forest fire records (Table 2.7; See "Fires by Decade", Appendix B-1). Historically, fires were ignited by lightning, Native Americans, sheepherders and local residents. Active fire suppression in the Entiat area began between 1910-1930.

During the time period from 1931-1994, 70 percent of the fires in the Entiat analysis area were caused by lightning. Between the 60's and 70's, lightning caused approximately 51-62 percent of the fires, with a steady increase to 74 percent in the 1990's.

Humans were responsible for causing 30 percent of the fires during the period from 1931-1994. As fire prevention programs became more focused and successful, human-caused fires have been declining each decade since 1970.

Considering all recorded fires within the analysis area, greater than 70 percent of the ignitions have occurred in the dry open and wet/mixed vegetation zones.

The Entiat analysis area has experienced some of the largest stand-replacing wildfires in the recent history of the Wenatchee National Forest (Entiat R.D. GIS 1994; Entiat R.D. Large Fire Map).

Table 2.7

Stand Replacing Wildfires - Entiat Analysis Area

Fire Name	Year	Acres Burned *	Percentage of Watershed Burned
Entiat Zone	1970	53,957	17%
Crum Canyon	1976	9,000	3%
Dinkleman	1988	47,580	15%
Tyee	1994	106,646	33% (some overlap with Entiat Zone)

* Corrections made in "acres burned" column in Version 2.0 reflect more accurate GIS outputs rather than the hand calculations used in Version 1.0.

Emissions

Emissions from prescribed fires increased in the late 1970's and 1980's as a result of increased unburning in the Open and Closed Forest vegetation zones. During the late 1980's and early 1990's, these programs were drastically reduced and emissions dropped to lower levels. Broadcast burning and wildfires have been the primary causes of emissions during the 1990's.

RANGE USES

The following summary of current range conditions on the two allotments within the analysis area was drawn from the range report found in Appendix G.

Existing Condition of the Potato Creek Cattle Allotment

Three vegetation types occur within the Allotment; timber, meadow and grassland, with the timber and grassland types predominating. Of the 44,640 acres in the Potato Creek Allotment, only 13,904 acres are considered suitable for grazing (as defined by the Wenatchee Forest Plan standards and guidelines for grazing utilization). This includes 5,902 acres of primary range and 8,002 acres of secondary range (Appendix G-3). Most of the range is considered unsuitable for grazing due to the soils and watershed conditions (mainly steep slopes and erodible soils).

The overall condition of the Allotment is fair to good. Riparian areas were found to be in mostly poor or very poor condition and have not met recent Forest Plan utilization standards. The mid-level shrub component is disappearing and tree regeneration is lacking (especially aspen). This is mainly due to the concentration of cattle. The riparian areas and valley bottoms are providing 80 percent of the livestock forage. Landowner conflicts occur because livestock tend to concentrate in valley bottoms near private land.

Before the 1994 Tyee Fire, condition and trend transects revealed that several areas were beginning to show slight improvement in conditions. However, native bunchgrass ranges are slow to recuperate due to low annual precipitation. Improvements in range condition are expected to be gradual and will take some time.

After the Tyee Fire, high and moderate-intensity burned areas were seeded during the Burned Area Emergency Rehabilitation (BAER) effort. The Allotment has been closed to grazing until further notice. There is a set of criteria to determine range recovery (Appendix G-4). Once these criteria have been met, livestock will be permitted to return. However, adjustments may need to be made to grazing numbers. Prior to re-entry, a capacity determination will be made on the level of livestock grazing permitted on the Allotment. Many of the range improvements were destroyed in the Fire.

Noxious weeds (predominately knapweed) as well as other undesirable weedy plants have increased within the Allotment. This is especially prevalent along roads and valley bottoms. Additional past disturbances, including logging and road building, have aided in the further advancement of noxious weeds.

Existing Condition of the Mosquito Ridge Sheep and Cattle Allotment

Three vegetation types occur in the Allotment; timber, meadow and grassland, with the timber and meadow types predominating. Of the 11,600 acres in the Mosquito Ridge Allotment, only 6,900 acres are considered suitable for grazing (Appendix G-3). Most of the range is considered unsuitable due to the soils and watershed values (mainly steep slopes and erodible soils).

The range condition is considered mostly fair with some areas in poor condition. The poor condition areas are mostly bedding areas or trailing routes. For a full description of the term "range condition" refer to the complete Existing Condition discussion for the Potato Creek Allotment found in Appendix G-2.

During the 1994 Tyee Fire, 4,000 acres of the Allotment were burned at light to moderate intensities. This area was partially seeded during BAER efforts and overall, good vegetation recovery is expected. This area is closed to grazing until further notice. The unburned area was not affected and grazing continues with a new routing schedule. The Mosquito Ridge Allotment must also meet the criteria that have been established for range recovery before livestock can re-enter the burned area (Appendix G-4).

In many areas, noxious weeds (predominately knapweed), as well as other undesirable weedy plants, are increasing. This is especially prevalent around areas of high concentrations, such as bedding grounds, trailing routes, and watering areas. Additional past disturbances, including logging and road building, have aided in the further advancement of noxious weeds.

Future Range Program

Grazing is expected to continue within both allotments. Animal numbers may fluctuate and the terms of current permits may change according to management direction. A more intense range management program is needed in order to improve the condition of the range and to meet Forest Plan Standards (refer to Appendix G-4 for desired conditions of the Allotments). Cooperation between the Forest Service and permittees is imperative for the success of improving rangelands on the National Forest.

RECREATION USES

Overview

The recreation objectives on the Entiat Ranger District are to preserve present and future outdoor recreation experiences, prevent unsanitary conditions, protect water quality, and prevent wildfires resulting from recreation activities. Additionally, all reasonable measures necessary to provide for the safety of recreation users will be taken. Coordination between differing or competing recreation uses or values will occur so that existing and future recreation opportunities will be preserved without adversely affecting other resources.

The Entiat River and major tributaries provide users a diverse recreation experience, ranging from more developed campgrounds to undeveloped primitive camps and from primitive and single track trials to asphalt barrier-free trails. The Entiat Valley provides a little something for everyone, regardless of the recreation preference. The following section summarizes the current recreation management situation in the analysis area. The complete text of this recreation report is available in Appendix H.

Developed Recreation

Current Management Situation - Most of the developed recreation on the Entiat is confined along the Entiat River, except for the Pine Flats Campground, which is located along the Mad River. Entiat Ranger District provides recreationists with 107 family-oriented camp sites (refer to Appendix H-3.1) with all but 11 being fee sites (full-service sites), two observation points, two summer home tracts and two group reservation sites.

Over the past decade, recreation use on the District has increased steadily, with weekends currently running over 100 percent capacity and weekday use currently running 50 to 60 percent during July and August. Silver Falls complex is the most popular recreation area with the campground receiving approximately 27,000 visitors annually. The National Recreation Trail receives an additional 6,000 visitors annually. Currently, the condition of the District's recreation facilities ranges from good to poor.

Recreation Trails

Current Management Situation - The Entiat Ranger District provides the trail traveler with a wide range of recreation experiences. Currently, the District manages 292 miles of forest single track trails. This system is divided into three differing management areas - Wilderness trails (65 miles), Non-motorized Trail System (35 miles), and Multiple-Use Trails System (184 miles). There are also 6.5 miles of Hiker Only trails. For further information on tyrails and trailheads refer to Appendix H-2 and Table H-3.3.

> **Wilderness Trails** - These trails are closed to all mechanized modes of travel. This entire trail system lies within the headwaters of the Entiat drainage and consists of 65 total miles; 41 miles of standard maintenance class and 24 miles of less than standard maintenance class (see Appendix H-4 for definitions). The main access route into this trail system is from the Entiat River Trailhead at Cottonwood up through Entiat River Trail #1400, which serves as the main portal into the Glacier Peak wilderness. Popular destination spots, within the Entiat Ranger District's portion of the Glacier Peak Wilderness area, are Larch Lakes, Ice Lakes, Entiat Meadows and Entiat Glacier (refer to Appendix H-3.2 for the percentage of use at destination spots in the Upper Entiat Trail area).

Non-Motorized Trail System - This trail system lies primarily in the North Fork of the Entiat River and consists of a total of 35 miles; 23 miles of standard maintenance level and 12 miles of less than standard maintenance class. Prior to the implementation of the 1990 Wenatchee National Forest Land Management Plan, this trail system was managed as multiple use, with motorized travel being allowed. The signing of the Forest Plan closed the area to motorized travel.

Multiple-Use Trail System - The multiple-use trail system managed by the Entiat Ranger District represents the hub of one of the largest and most unique systems of interconnecting trail networks in the Northwest consisting of over 235 miles of trails, 184 of which are on the Entiat. This system is primarily used by the motorized recreationists, but is also enjoyed by hundreds of individuals utilizing mountain bikes, equestrians, hikers and an occasional llama packer (see Appendix H-3.4 for Use of the Area table). More than 50 percent of the use which occurs on the District's Multiple-Use Trail System originates from western Washington ~~(refer to Appendix H-3.5)~~.

The overall condition of this system is very good. This is due primarily to funding grants, which exceed three quarters of a million dollars, from the Washington State IAC NOVA program (Washington State Parks and Recreation Department, Inter-Agency Committee for Outdoor Recreation, Non-Highway and Off-Road Vehicle Activities). Over the past 15 years, these funds have enabled the Entiat Ranger District to develop or redevelop to standard many of the trails and facilities along the multiple-use trail system. Currently, two-thirds of the Districts maintenance funding for this system comes from IAC program. This program is directly responsible for enabling the District to reduce its backlog of less than standard maintenance levels (refer to Appendix H-3.6 service levels). This system also receives hundreds of volunteer hours from organized user groups in order to upgrade degraded sections of trail.

The Upper Mad River area is the most popular destination within this system. The gentle topography of this area and trails with limited exposure to danger make this an attractive recreation area.

Dispersed Recreation

Current Management Situation - Currently, the District has an estimated 250 dispersed camps scattered throughout the Entiat Valley, 200 of which have been mapped. Extensive impact surveys have been completed only for camps in the Wilderness. These dispersed areas provide opportunities that are very different from those found in more developed locations. Most camps throughout the District are concentrated around water sources.

Winter and Other Recreation Activities

Current Management Situation - Winter recreation (consisting mainly of snowmobiling) is one of the Districts fastest growing recreational activities. This is primarily due to the congestion that is occurring at other recreation areas in the state. Currently, the Lake Wenatchee Ranger District grooms the route from Eagle Creek along Entiat Ridge to Sugarloaf Lookout and Chelan Ranger District grooms the route from 25 Mile Creek over Shady Pass and down to the Sno-Park located 1/2 mile above the forest boundary sign along the Entiat River Road. Recreation use varies from area to area, the highest-use area being along the Entiat Ridge.

Other Recreation Activities

These include hunting, fishing, and sight-seeing from forest roads and trails. Currently, use figures are not available for these other forest uses. In 1996, however, an extensive use-monitoring system is being initiated.

CHAPTER 3

STEP 7: Integrate, Interpret and Present Findings

During each iteration of this analysis, this step was accomplished in a three day team interactive process referred to as "synthesis". Synthesis involves the group evaluation and analysis of information on all resources, resulting in recommendations that reflect the integration of findings.

Overview of the Synthesis Process

The following process was followed for both iterations of this assessment:

Analysis Report - Team members reported findings made during completion of the modules. Module analyses were directed at addressing one or more of the key questions identified in Chapter 1. These reports gave all team members a common understanding of the watershed conditions for other resources. Only those questions relating to clarification were allowed. It was important to listen and think of how the information being presented related to other resources.

Inter-relationships - After hearing all modules, this step allowed each team member to respond to what was presented in step 1. The key was to identify "linkages" that have a bearing on what is going on in the watershed.

Desired ecological conditions - Each module leader presented "desired ecological conditions" related to their module. These had been alluded to in steps 1 & 2 but this was an attempt to state them in succinct bullets. These conditions were also tempered by what had been learned/shared in the first two steps.

Management strategies - Produced an integrated list of opportunities for achieving desired ecological conditions. These will be the direct link to restoration projects and other proposed activities. This also was the time to identify needed changes to forest plan standards and guidelines.

There were four very important outcomes from this process: **1) Existing Conditions**; **2) Resource Linkages**; **3) Desired Ecological Conditions**; and **4) Management Strategies**. These outcomes are the building blocks of this watershed assessment. They demonstrate the accuracy of issues and lead to logical management strategies and provide the ecological rationale for future management within the Entiat Analysis Area.

The recommended **priorities** established by the Version 2.0 IDT for implementation of these management strategies are identified in Chapter 5. Chapter 5 also includes recommended geographic priorities for restoration work and recommendations for monitoring activities and follow-up actions resulting from this analysis. The following section discusses the linkages identified during the synthesis process:

LINKAGES

Following is a discussion of the resource linkages identified during the synthesis step for both Version 1.0 and Version 2.0. These "linkages" consist of both basic concepts and new insights ("Aha statements") derived by the teams during synthesis. The following narratives and lists are not intended to be complete or exhaustive descriptions of every applicable inter-relationship.

VEGETATION

The following vegetation-related, resource linkages were identified during this analysis:

Tree Densities

Currently in the Entiat, in the closed forest group, burned areas have few living trees. In unburned areas, tree densities are currently much higher than pre-settlement times and tree diameters are smaller within the same closed forest group. This increased tree establishment typically began 60-70 years ago--reflecting a reduction in grazing and the beginning of more effective fire suppression efforts. What were once open and park-like stands are now either standing dead (if burned) or dense regeneration to pole-size trees beneath a residual overstory of larger trees (if unburned). The dense stand conditions result in higher disease susceptibility and higher risk of catastrophic fire. This stand density also reduces the ability of the stand to produce large-size structural components for wildlife and other purposes.

Plant Community Structures

Although related to the previous discussion, the structure of plant communities is influenced by a number of factors discussed during synthesis. Disturbance can strongly affect community structure and fire is a primary disturbance agent in much of the Entiat. Structural change resulting from fire suppression is most noticeable in the closed forest group. Here, fire suppression has altered plant community structures from typically single-layered stands with small patches (<¼ acre) of young trees interspersed with larger patches of primarily grass/forb understory to communities that are now two-layered(or more) consisting of small stressed and crowded trees under a widely-spaced overstory. Fire suppression and grazing have shifted the understory from grasses and occasional shrubs to fire-intolerant trees and shrubs.

Timber harvest has further complicated the structure of these communities. Structural changes affect wildlife habitats, timing of snow melt and runoff regimes. Structural changes that result in the development of a sub-canopy layer of stressed trees that serve as "ladder fuels" also dramatically change the disturbance regimes, particularly fire. This change in fire regime has been a primary cause of the catastrophic fires in the Entiat area in recent years.

Similar processes have resulted in similar changes, to a lesser degree, in the open forest group. Plant community structure changes are relatively minor in other groups.

Exotic Plant and Species Composition

Many non-native plants have become established in North America since the early part of this century. Most are very aggressive and can outcompete native plants in some instances. In the Entiat, the most important weeds are diffuse knapweed, dalmation toadflax, yellowstar thistle and cheatgrass with diffuse knapweed and cheatgrass currently the most prevalent. Any ground-disturbing activity can result in these weedy species gaining control of a site. Past grazing, logging and road building have contributed to the spread and current abundance of weeds. Weeds replace native plants in many cases; changing community function and composition and also modifying the site potential. These weeds are particularly unhindered in their potential distribution in open conditions such as in the shrub/steppe or open forest groups. Transportation systems also facilitate the spread of weeds. Weeds can also become a problem in developed recreational sites where use is intense, weed seeds can be brought in from off-Forest and bare soil areas provide suitable habitat.

Dispersed recreation can also add to this problem, especially from recreational vehicles transporting seed and stock feed containing weed seeds. Establishment of weed populations on the Forest, where weed seeds can get into streams, can result in weeds being spread to all the areas where the water is used for irrigation.

Fire, particularly intense fire, can also cause increases in weed populations. Even low-intensity fire, particularly in open areas, can result in the killing of some perennial species--leaving a niche for weeds to become established. Conversely, some of the rare plants in the Entiat may have been favored by historic recurrent fire and consequently, fire suppression may have been detrimental to some sensitive plant populations. Now, with the presence of alien weeds, the benefits of prescribed low- intensity fire must be carefully weighed against the potential for increased weed populations.

Management and Vegetation

Past livestock grazing in the Entiat was intense, involving sheep, cattle, horses and even hogs. This grazing has affected plant community composition and weed populations, and the evidence still remains. In the high country, where tens of thousands of sheep grazed annually, changes in community composition and "terracettes" still remain as evidence of overuse. This grazing led to soil compaction, soil loss, and community changes--thereby affecting landscape vegetation. In the lower elevations, past intensive grazing is typically reflected in the prevalence of exotic plant species and some areas where "terracettes" can still be seen. Timber harvest has also affected vegetation compositon. Accessible areas were, early in the century, harvested--commonly with ponderosa pine being the preferred species. Consequently, many of the large accessible pines are gone from the lower Entiat. Douglas-fir has become proportionally more dominant due to this harvest activity and to fire suppression. Removal of the large trees while leaving the small ones, and the increase in survival of the smaller tree cohort (because of fire suppression) has also reduced trees sizes overall. Historic harvest has also diminished the character and condition of visual resources.

Another linkage concern is the efficacy of Burned Area Emergency Rehabilitation seeding after both the fires of 1988 and 1994. Questions include: How has the rehabilitation seeding affected the re-establishment of native plants? Was the rehabilitation seeding effective in reducing surface erosion? How long will the seeded species remain? All these questions suggest an urgent need for monitoring in the fire areas.

Erosion and Vegetation

Prior to the recent intense fires, fire suppression activites laid the ground work for increased vegetation density and subsequent fuel buildup. In areas that had high fuel loadings and attendant severe burning conditions, burn intensities were high. Increased burn intensity killed a high percentage of vegetation and will undoubtedly result in increased erosion. The high percentage of high and moderate burn intensities from the recent fires in the Entiat are a result of excessive fuel buildup and will result in increased soil erosion. Many of the shrub/steppe and open forest areas are located where granite and/or gneiss are the predominant substrates. These rocks tend to break down to sandy material such that the soils are droughty, readily subject to mechanical surface erosion and often have a poorly-developed A horizon. This ready surface erosion provides many opportunities for alien weeds to become established and flourish.

Forest Health

Past harvest and fire suppression have typically resulted in stands that have higher insect and disease incidence, commonly out of the presumed range of pre-settlement stands. Much of the Entiat reflects very dry forest conditions, where trees are under moisture stress and yet tree densities (before recent fires) were high. These conditions lead to higher insect and disease incidence. Recent fires have sanitized some of these stands, but the density of the understory tree component and the ability of pathogens to kill many of those trees contributed to the higher fire intensities of recent fires.

Landscape Vegetation Pattern

Macroclimate, microclimate and substrate are major drivers in the distribution of vegetation types across the landscape. Disturbance events further modify this pattern, creating landscape diversity from various successional stages. The elimination of recurrent fire prior to the recent large wildfire events lead to a simplified

for 1994 stated that habitat selection for grassland and shrub/steppe was greater than availability in Swakane Canyon.

Certain bacteria carried naturally in domestic sheep are lethal to bighorn sheep. Therefore, these two species are incompatible on the same range.

Deer

Deer are more resilient to changes than many other species. However, deer compete for food cover and water among themselves, with other wildlife, and with human resource uses.

Deer densities are reduced on preferred ranges when cattle are present. Deer home ranges may be expanded in the presence of cattle. The season of use affects forage selection by domestic livestock. In late summer and fall, after their preferred forage dries out or when preferred forage is depleted, cattle use more of the plants needed by wintering deer, thus impacting winter range carrying capacity. Spring and early summer grazing in fawning areas reduces deer densities, forage abundance, and cover for fawns.

Livestock grazing can impact vegetation height, density and composition, thereby affecting nesting and foraging patterns of birds especially in shrub/steppe and open forest communities (i.e., loggerhead shrike, marsh harriers, upland sandpipers, and sage grouse).

Wildlife and Recreation

Improved human access into the forest via roads, trails, and ORV's, affects wildlife by increasing disturbance, reducing use of key habitats or areas. Reduced use of habitat by wildlife equates to loss of habitat. Access routes may also be used to manage human activities by routing recreation use away from key habitats or to selected recreation areas.

Recreation use on wildlife refuges was documented to result in lowered productivity, aberrent behavior, reduced use of habitat and the refuge, direct and indirect mortality.

Big game use of an area is affected by human use. Road access affects use of large areas by deer and elk. Roads also impact habitat use patterns by black bears and grizzly bears. Avoidance of roads by grizzly bears appears to be independent of traffic volume.

Deer respond to low intensities of snowmobile use and their response increases with the duration of the disturbance. Deer that are not hunted become somewhat habituated to snowmobile traffic. Even in regularly used areas they move back and forth as the disturbance varies, increasing stress and the use of energy reserves during the critical period, and increasing their vulnerability to predation. In little-used areas, some deer move their home ranges when disturbance is introduced, so the population density in the area is reduced. The study from which the above was found was performed on white-tailed deer. Other studies on mule deer also documented responses to snowmobiles and even greater responses to humans on foot. Harassment of mule deer does by ATVs reduces reproductive success.

Snowmobile routes often run through habitats used by lynx, marten, wolverine and fisher, which allows access into these areas for trapping and incidental or illegal taking of these species. Snowmobiles can impact small mammals living under the snow in winter by compacting the snow, blocking travel routes, reducing insulation quality, reducing air spaces and possibly increasing CO_2 concentrations.

Recreation developments often concentrate human use near sites, such as water, ridgetops (view areas), and other unique areas that also attract wildlife, so conflicts occur. Detrimental effects are most often on wildlife, but hazards to humans can also result (e.g., bears attracted to garbage, etc.,). Lambing/kidding areas for bighorn sheep and mountain goats, roost and nest sites for raptors and other large birds are found in these sites and are vulnerable to disturbance by recreation and other human activities.

Riparian

Riparian habitats are the most productive on the Forest. In the lower Entiat, riparian, wetlands, seeps, springs and meadows have been significantly altered from historic conditions. The loss of these wetlands and the disturbance of water by grazing reduces amphibian reproductive potential.

Reducing beaver by trapping or by depletion of their habitat has adversely affected the riparian functions (reduced water levels). Riparian vegetation shows a higher percentage of conifers due to lowered water tables. In-stream pool percentages are reduced. Silt collection areas and streamflow regulation are reduced. Heavy grazing reduces bank cover and other riparian vegetation important to wildlife. Before beaver can be permanently re-established in an area, riparian vegetation (primarily willows and aspens) will need to become re-established. This vegetation needs to be of sufficient size, abundance and distribution to withstand foraging by beaver, big game and livestock.

Riparian habitat with open water is important to deer winter range and for fawning. Domestic grazing and roads in riparian areas reduce the amount of cover and food available in these areas and may alter access to water.

SOIL/WATER/FISH

The following soil/water/fish-related, resource linkages were identified during this analysis:

Landform and Climate

Geologic, landform and soil features, combined with climatic factors, are strongly influencing ecological processes in this analysis area. This relates to streamflow, sediment yield, slope stability, channel condition, seeps and near-surface ground water.

* The broad ecotone between major vegetation groups is linked to available soil moisture.
* Entiat subbasin is geologically young - links to comparatively high activity of natural processes (erosion, delivery, transport and deposition of sediment).
* Change from perennial to intermittent flow in some streams in lower vegetation group (shrub/steppe, open forest and some closed forest) linked to climate, change in vegetation (species and density), loss of beaver, altered hydrology and sedimentation from roads, grazing and harvest.
* Sediment/substrate size is linked to geology (finer in lower, non-glaciated zone; coarser in upper, glaciated zone).
* Hanging valleys have high sediment delivery ability.
* Water storage capacity of glacial tills is linked to stable flows and low water temperatures - linked to Mad River bull trout habitat and good wildlife habitat (especially amphibians) in upper vegetation groups (closed and open subalpine).
* Watershed conditions in the upper vegetative groups (subalpine) are a key link to maintaining downstream water quality and habitat conditions in the mainstem.
* Ash/pumice soils have high erosion hazard - links to fine sediment in lower vegetation groups (shrub/steppe, open forest).
* Dense drainage systems in lower vegetation groups - links to high sediment delivery rates.
* Streams in lower vegetative groups lack flow to remove sediment accumulation, a link to interrupted/intermittent flows.
* Lower vegetation group subject to low precip, high evaporation, snow redistribution and some deep infilitration - links to moisture stress and south aspects incapable of supporting closed canopy stands and recovery of native grasses.

* Debris slides in coarse glacial till link to large woody debris recruitment and high pool ratio in upper vegetation groups.
* High percentage of exposed rock in upper vegetation groups links to rapid and high peak runoff.
* High runoff and steep channel gradients cause downcutting - links to natural fish barriers in upper vegetation groups.
* Road crossings as obstructions - linked to altered woody debris recruitment.
* Formation of anchor ice may be a significant link to decreased fish egg and early juvenile survival in the lower Entiat.
* Zero order watersheds ("catchments") are critical to maintenance of hillslope hydrologic function.

Management Activities

Historical land uses/interventions have strongly influenced: vegetative patterns, sediment, wildlife populations, stream channels, soil productivity, streamflow, water retention, fire occurrence, fish habitat and exotic species.

* Ground-disturbing activities are linked to accelerated natural processes of erosion and sedimentation.
* Fish populations have declined (except introduced sockeye and brook trout) linked to increased human access/management activities.
* At-risk fish species are sensitive to management activities.
* Channelization has eliminated or severely reduced side channel habitat, floodplain access, sinuosity, and much "roughness", especially in the lower Entiat below the National Forest. All links to altered natural function.
* Reduction of the native deciduous component of riparian vegetation links to decreased aquatic productivity in the lower vegetation zones.
* Road building (particularly in riparian corridors) and/or timber harvest are linked to:
  - modified/reduced riparian vegetation in lower vegetation groups, links to reduced large woody debris, reduced shade, and increased water temperatures,
  - constrained channels and simplified riparian/aquatic habitat in lower vegetative groups.
  - detrimentally altered hillslope hydrology (flow interception and concentration), especially in high road-density sub-watersheds.
  - accelerated erosion and sediment delivery, links to decreased quality of water and fish habitat.
* Past water uses associated with private lands in the lower Entiat are linked to:
  - significant barriers to anadromous fish passage by damming.
  - reduced anadromous spawning from dewatering.
* Past over-grazing is linked to:
  - altered understory and ground cover vegetation, creating a seed bed that favors tree encroachment.
  - severely displaced and compacted soil A horizon, especially south aspects - links to altered hydrology and invasion of noxious weeds.
  - reduced deciduous component of riparian zone vegetation.
  - increased tree stocking densities in combination with aggressive fire suppression.
  - increased surface runoff, erosion and sedimentation

* Past fires and fire suppression are linked to:
  - both removal and recruitment of instream large woody debris
  - modified water yield characteristics (including ground water) of affected watersheds (+total yield, +base flow, +peak discharge, +storm flow, earlier runoff and peak flow, reduced runoff response time).
  - modified sediment yield characteristics (+transport capacity, +surface erosion, +mass erosion).
  - accelerated tree encroachment and survival.
* Long-term recovery required for degraded vegetative conditions in alpine climate (cold) and in lower elevations (weeds & moisture stress.
* Developed and dispersed recreation have adversely impacted soil productivity (compaction, erosion) and vegetation in localized areas.

Altered Disturbance Regimes

Vegetative patterns and associated habitats have changed dramatically from historic condition because disturbance regimes have been altered (e.g., wildfire, insects and disease, etc.).

* Fire suppression is linked to increased tree density, increased basal area and increased evapotranspiration, which may link to reduced flows.
* Increased post-fire base flows are linked to fire-killed trees, reduced ground cover, etc.
* Increased floods and debris flows are linked to large fires (within five years).
* Lower vegetation groups have highest risk for major flood events, which are linked to low-frequency, high-intensity, stand-replacing fires, which are linked to past management (grazing, fire suppression, harvest).
* The trend in fire intensity from low to high is linked to past management activities.

SCENERY

The following scenery-related, resource linkages were identified during this analysis:

From a scientific viewpoint, human intervention in fire regimes and resulting vegetation patterns are viewed as not natural. From a social and scenery resource viewpoint, however, the resulting vegetation patterns are viewed as natural appearing.

Scenery management affects ecosystems and ecosystems affect scenery and landscape aesthetics. The structure and function of different ecosystems provide diversity as well as a variety of recreation experiences and sensory perceptions.

Scenic attractiveness, variety class, and geomorphology have a direct link to scenic quality. Open park pine stands that have form, line, color and size have been replaced by other species through management.

Scenic corridors in the Entiat Valley have been maintained at high scenic levels through landscape management techniques.

Wildfire softens the effect of past management practices of form and line introduced in the landscape (which appear altered prior to a wildfire).

Vegetation manipulation can affect scenic quality, both positively or negatively.

People are drawn to open ridge tops for viewing and to riparian areas for recreation and sensory experiences.

Maintaining high levels of scenic quality is not expected on private timber lands because land management objectives are different. Scenic quality on public lands will be desired or sought as adjacent lands in the area are developed or managed.

The Entiat Valley will change from a rural-feeling area to one that is more developed.

Additional Linkages, Columbia River Tributaries

The Columbia River and Navarre Coulee viewsheds have been maintained at high scenic levels through landscape management techniques. Grazing affects scenic quality, and in the past, overgrazing has had a negative effect on scenery in some areas.

U.S. Highway 97 and Highway 971 are a segment of the Cascade Loop Tour, which has an international draw. The Columbia Breaks country is a scenic backdrop for this segment.

FIRE

The following fire-related linkages were identified during this analysis:

Fires in the decades of the 20's through 60's were typically small, mostly "spot fires," less than 1 acre in size. This was primarily due to the success of fire suppression actions and the naturally low fuel loadings. There were few fires that were larger than 500 acres; however, two notable exceptions were the Entiat Zone Fire of 1958 (6,500 acres) and the Tenas George Fire in 1961 (3,700 acres). Both of these fires burned in the "flashy" fuels of the shrub/steppe vegetation zone.

Fires have recently been larger and more intense due to the effects of harvest activities, accumulations of natural fuels resulting from fire exclusion and the effects of the current drought.

Historically, the shrub/steppe and open ponderosa pine vegetation zones had scattered larger down woody fuels with few ladder fuels, rather than a fuel profile of smaller, continuous fuels.

SYNTHESIS SUMMARY TABLES

The six tables on the following pages summarize the results of the synthesis process for both iterations of this watershed assessment. The tables are labeled 3.2 through 3.7, with Table 3.2 covering items that are common to all vegetative groups, and Tables 3.3 through 3.7 corresponding to each of the five vegetative groups. The existing conditions and desired ecological conditions are described. Management strategies are identified to move the existing condition towards the desired condition. The recommended priorities for implementation of proposed management strategies are discussed in Chapter 5.

Desired conditions are focused at identifying ecological conditions and are not intended to make decisions as to the occurrence or intensity of any particular management activity (e.g., developed recreation, grazing, timber harvest). Specific decisions regarding management activities will be made at the NEPA planning level.

Table 3.1 below illustrates the relationship between the dominant issues that framed the scope of both iterations of this assessment (Chapter 1) and the management strategies that resulted (Tables 3.2 - 3.7). **Appendix K** provides an index to the management strategies listed in Tables 3.2-3.7.

Table 3.1
Assessment Issues and Related Management Strategies
Entiat Analysis Area

Issue *	Management Strategy # **
1. Vegetative Structure & Condition	3,8,9,13,15,17,18,28-30,33,34,36,46-50, 52-55,58,60,62-64
2. Wildlife and Fish Populations	1,2,5,6,7,10,12,15,16,18,23,25,26-37,45, 47,49-56,58,59,62,63
3. Historic Events/Human Impacts	2-18,21,23,26-31,34,36-42,46,47,57-59, 61,64
4. Sedimentation	1-7,10-12,17,18,30,34,36,57
5. Scenic Quality	7,11,13-19,21,23,24,30,34,36,38-43,47, 49,53,55,60,62,63
6. Watershed Improvement Efforts	1-7,10-12,18,19,27,29,34,36,37,46,47,57, 61
7.Commercial Livestock Grazing	3,6,8,10,25,30,33,44,45,64
8. Recreation	7,10,11,14,16-24,26,31,42,43,51

* Issues as listed in Chapter 1.
** Management strategies as listed numerically in Tables 3.2 through 3.7.

Table 3.2
Conditions and Management Strategies Common to All Vegetative Groups within the Entiat Analysis Area

Common Management Strategies

Existing Condition	Desired Conditions	Management Strategies (MS)
Riparian & Wetland Function: In areas where riparian or wetland function is impaired, conditions may include: reduced sediment buffering, decreased organic matter input (fines to large woody debris), increased temperatures, unstable banks, reduced water storage & reduced riparian vegetation. Diminished riparian and hydrologic function translates into decreased habitat structure and diversity.	Improved riparian/wetland hydrologic function to buffer sediment delivery (ground cover), enhance nutrient cycling, provide security & thermal cover, improve channel stability and flow regulation. Sustained, diverse riparian vegetation condition and structure.	**1)** Designate Riparian Reserves using guidelines from WNF Forest Plan, as amended by the NW Forest Plan, until site-specific analysis can refine width needs. **2)** Implement actions that promote maintenance or improvement of riparian area function and channel stability (e.g., road upgrade, relocation or obliteration, beaver re-introduction, revegetation, obstruction removal, large woody debris/ boulder placement, water chance reconstruction, etc.). Also follow MSs 34 and 36.

Common Management Strategies (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Soil Quality & Hydrologic Function: Soil productivity losses have occurred due to decrease in ground cover, compaction, concentration of runoff and accelerated erosion. The extent and magnitiude of this reduction varies widely over the analysis area, depending on the location and cumulative disturbances involved (grazing, high intensity fire, timber harvest, roads, recreation). **Catchment basins** (zero order drainages) provide important hydrologic functions (collection, storage & release) which may be locally impaired by soil compaction and other detrimental disturbances.	Soil-hydrologic processes are properly functioning: infiltration/ percolation rates, storage capacity and release of water are restored. Physical/chemical conditions of the soil profile support overstory and vigorous understory plant communities and associated organic matter content (duff and soil wood) that are within the ecological capability of the site.	**3)** Implement management activities that achieve Forest Plan standards for soil productivity, ground cover & grazing utilization. Also follow MSs 5, 7 & 29. **4)** Implement restoration treatments which will establish conditions where soils within activity areas will make significant progress toward properly functioning conditions. Investigate and implement ecologically sound techniques for reducing detrimental soil disturbance. Also follow MSs 3, 5, 47, 55, & 61. High priority in depostion zone (LTA E), moderate in transition (LTA C), low in transport zone (LTA A, B).
Tyee Fire-Flood Risk: There is an increased risk of flooding with associated threats to life and property due to the effects of the 1994 Tyee fire.	Vegetative ground cover is restored; Infiltration rates on hydrophobic soils are restored; Concentration of surface runoff is reduced, especially on roadways.	**5)** Implement projects to reduce surface runoff and surface/mass erosion from disturbed sites, especially from roads and moderate-high intensity burned areas (e.g., site revegetation, log terracing, road obliteration, road surfacing, surface water control, activity avoidance, etc.). Also follow MSs 2, 3, 7, 29, 34, and 36.
Critical, Unique and Key Species & Habitats: Critical, unique and key habitats for PETS, MIS and S&M species of plants and animals occur in the analysis area. Many of these components are limited and susceptible to natural and management disturbances. The location of many of these species & habitats is unknown. Adequate condition and trend data are lacking to determine status of some of these species	Critical, unique & key species and habitats locations are identified, sustainable and in sufficient quality and quantity to insure species viability.	**6)** Identify critical/ unique/key species & habitats and their limiting components. Develop species management guides for species & habitats as needed to insure population viability to meet Forest Plan objectives. Avoid creating situations which will contribute to potential hazardous interactions between humans and wildlife. Develop Conservation Strategies and Agreements for sensitive plants, as needed. Consider use of protective Forest Plan designations for some of these sites (e.g., Special Interest Areas). Also follow MSs 1, 2, 7, 15, 16, 29, 34 and 36.

Common Management Strategies (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Road and Trail System: Road density is high in several subwatersheds. A high percentage of lower slope or riparian roads exists in many of these areas. The maintenance needs of the existing road system exceeds annual funding levels. Poor surface water control on roadways alters hillslope hydrology and increases erosion & sedimentation. Riparian roads alter floodplain function. Dense road and trail systems increase human activities, reducing wildlife security, and limiting wildlife use in Fall, Winter and Spring.	The road and trail system is scaled properly to meet access needs and maintenance limitations, while reducing negative impacts to wildlife and other resources (e.g., runoff concentration and accelerated sedimentation from roads and trails is significantly reduced, especially at stream crossings. Hydrologic function is restored. Open road densities are limited in habitats where access is a management concern (e.g., mule deer winter range or near raptor nest sites).	7) Continue implementation of restoration projects treating priority, road-related problems. Complete and implement an Access and Travel Management (ATM) Plan that will establish season of use, road densities, closure strategies, maintenance requirements, etc. for the system. Develop ATM in concert with development of the Comprehensive Recreation Use Strategy Plan (MS 16). Use trail or road closures as needed to direct recreation use away from key habitat areas and/or areas allocated to specific uses. Identify access routes used for dispersed recreation, level of use and potential conflicts with wildlife/plant habitats. Also follow MSs 2 & 5.
Noxious Weeds: Noxious weeds are present. Soil conditions and ground disturbing activities promote further spread. Decline in vegetative conditions is especially prevalent in areas with soil productivity losses (e.g., soil disturbance/loss through accelerated erosion of sandy soils in shrub/steppe). Problems are most significant in the open vegetative conditions of the shrub/steppe, open forest and open subalpine; whereas, roads, trails and short-term openings are a concern in the closed forest and closed subalpine.	Noxious weeds are absent or at very low levels. Healthy stands of native vegetation retard invasion and establishment of noxious weeds and soil productivity losses are minimized.	8) Develop an integrated weed management strategy for the area. Reduce the risk of infestation and spread of noxious weeds. Establish desireable, aggressive grasses and shrubs capable of restricting expansion of weeds, using natives where possible (e.g., Mud Creek meadows). Consider direct control activities on populations. Identify highly erodible, invasion-prone areas as unsuitable for livestock grazing in Allotment Management Plans, including the Columbia River Breaks. Also follow MSs 3, 7, 29, 30 & 44.
Burned Area Rehab Seeding: Effectiveness of burned area rehab seeding and ability of native plants to re-establish after rehab grass "withdrawal" is a concern.	Native plants filling in behind burned area rehab seeding and/or dominating sites.	9) Evaluate and monitor vegetation to determine extent of problem regarding burned area rehab seeding effectiveness, native plant recovery and noxious weed response. Also follow MSs 8, 29, 30, 34 & 36.

Common Management Strategies (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Planning Coordination: Coordination between the public, private landowners, land management and regulatory agencies, and the Yakama Indian Nation on resource management issues has been limited.	Coordination on management issues and actions provides a role for all stakeholders in the watershed.	**10)** Foster coordination with the public, other agencies, landowners, tribes and the Entiat Community for aquatic, riparian, fire protection and recreation issues to accomplish mutual watershed goals. **11)** Expand existing public involvement and information program, focused on a shared understanding of the ecological roles of people, fire, erosion, etc. Continue active support of Columbia Breaks Fire Interpretive Center.
Inventory/Monitoring Coordination: Various agencies and private citizens are collecting inventory and monitoring information on resources and management activities within the analysis area; however, coordination of these efforts is still somewhat limited.	Inventory and monitoring activities conducted in the drainage are well coordinated, eliminating duplication of effort, increasing quality control and improving information sharing.	**12)** Implement a coordinated monitoring plan targeted at priority issues and post-fire recovery, including an early warning system for storm events.
Landscape Appearance: Some of the landscape is in an altered condition as shown on the scenic condition map.	Landscape appears to be natural.	**13)** Within the Tyee Fire perimeter, maintain representative mix of all 3 burn intensities for short term scenic purposes. Also follow MS 34. **14)** Revise the Entiat Valley Visual Corridor Plan (1978) in concert with the recreation use plan (MS 16).
Snags and Logs: Within burned areas, large amounts of standing dead trees exist now in all size classes; there will likely be a shortage of snags in the future when these trees fall and before replacement trees can grow.	Snags and logs are present at levels meeting the ecological capability of the site.	**15)** Manage snags and logs based on site-specific analysis using current policies and guidelines (quantitative standards in WNF Forest Plan and NW Forest Plan in unburned areas; WNF Fire Recovery snag guidelines in Tyee Fire burned area).

Common Management Strategies (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Recreation Planning: Conflicts exist between user groups and values. During recent years the District has experienced an increase in recreation use (sightseeing, hiking, snowmobiles, motorcycles, horseback riders, mountain bikers to name a few).	No conflicts between competing user groups.	**16)** Develop a Comprehensive Recreation Use Strategy Plan linked to Access Travel and Management Plan. Discourage recreation developments near critical, unique & key wildlife habitats. Use trail or road closures as needed and other management actions to direct recreation use away from key habitat areas and/or areas allocated to specific uses. Identify access routes used for dispersed recreation, level of use and potential conflicts with wildlife/plant habitats. Foster coordination with the public, other agencies, landowners, and the Entiat Community to accomplish recreation goals and address recreation issues. Follow MSs 7, 10, 11, 14 & 40.
Developed Recreation Uses, Site Impacts: Heavy use of developed campgrounds and popular trailheads has resulted in: unacceptable levels of soil disturbance (compaction, erosion); vegetation loss/ removal (trampling, firewood cutting); excess noxious weed establishment; lack of down woody debris (particularly in riparian areas); and bank stability problems at localized concentrated-use points. User built trails are a problem.	Natural Appearing landscape character and scenic condition. Maintained and/or improved vegetative cover. Noxious weeds are minimized. Minimize adverse impacts on soil productivity, riparian and channel conditions at developed campgrounds and popular trailheads. Minimize transfer of adverse impacts to other areas (riparian areas). Acceptable travel routes are provided through riparian areas and acceptable recreation facilities are provided.	**17)** Vegetation management plan developed that will allow for long-term, sustainable use of the resource (Including noxious weed management). Harden high use areas with material compatible with ROS. Provide structures such as hitch rails to control stock at primary horse entry points. Evaluate sites and develop a management strategy that considers site upgrades, closures/hardening of sites and trails, locating areas for and constructing sanitation facilities. Limit vehicle access to dispersed sites. Turnpike, bridge, harden, or relocate trails to protect wet areas. Restoration of some areas as needed. Promote and educate public about using weed-seed-free feed. **18)** Implement a socially acceptable, developed site rehabilitation/maintenance program, to include: a) Public info about need to protect riparian vegetation & banks, b) Provide firewood & actively enforce cutting ban, c) Plant native grass/forb/tree species for ground cover & rooting, d) provide suitable cover in high-traffic areas (chips), e) rehabilitate damaged banks & f) relocate campsites away from banks wherever feasible. Also follow MS 20. **19)** Provide recreation stock facilities at appropriate developed recreation sites. Follow MSs 3, 8, 16, 20, 29, 36 & 38.
Developed Recreation Sites, Safety Concern: Dead, dying and defective trees pose a safety hazard.	Sites meet established standards for health and safety code.	**20)** Manage vegetation to be compatible with human use and safety. Also follow MSs 2, 3, 34, 36, & 38.

Common Management Strategies (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Dispersed Recreation Use, Site Impacts: Localized detrimental soil disturbance, particularly compaction, loss of gound cover, erosion and surface water concentration, has occurred at heavily used dispersed sites; especially at alpine sites (meadows) and trail channel crossings. Heavy use of dispersed sites has resulted in unacceptable loss/removal of woody debris and vegetation (trampling, firewood cutting). Dispersed sites have inadequate sanitation facilities.	Natural Appearing landscape character and scenic condition. Hydrologic processes are properly functioning; infiltration rate, storage capacity and release of water are restored. Minimize adverse impacts to riparian and channel conditions at dispersed sites. Minimize transfer of adverse impacts to other areas (riparian areas). Acceptable travel routes are provided through riparian areas and acceptable recreation facilities are provided. Sanitation strategies adequate.	**21)** Implement a socially acceptable dispersed site rehabilitation/maintenance program. Also follow MSs 2, 6, 7, 16-18, 34 & 38. **22)** Provide recreation stock facilities within the Wilderness and at appropriate dispersed recreation sites.
Change of Viewshed - Smoke and Dust Impacts on Air quality: Summertime dust from roads and trails, smoke from all types of burning, and "metro" area smog detracts from the viewing and recreation experience.	Natural Appearing landscape character and scenic condition. Clean air and clear views. Reduce the dust on major roadways and in campgrounds.	**23)** Promote well-constructed & maintained roads & trails. Use dust abatement techniques where appropriate. Reduce the number of roads or convert to trails. Also follow MS 7.
Expectation of Quality Recreation Facilities: There is a wide variety of recreation facilities at various levels of condition. In some cases needed facilities are absent or need to be upgraded to meet needs and accessibility standards.	Attractive, well maintained and designed recreation facilities appropriate to the ROS class of the area are present.	**24)** Implement the Accessibility Survey & Analysis. Prepare/update a condition survey of recreation facilities and develop a prioritized list of existing facilities. Identify potential areas of expansion. Also follow MSs 11, 18 & 40.
Domestic-Bighorn Sheep Contacts: Swakane bighorn sheep population is not growing as expected. There is a potential for disease in bighorn sheep from exposure to domestic sheep from adjacent allotments.	Desired population levels and areas to be managed for bighorn sheep are clearly defined.	**25)** Develop a comprehensive bighorn sheep management plan in cooperation with WDFW and USFWS. This plan will integrate existing State and Forest plans and will extend beyond the Entiat Analysis Area. Annual operating plans will require that domestic sheep grazing will be kept within allotments.

Common Management Strategies (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Native Aquatic Biota: Reduced native sport fish populations and altered distribution by stocking as a result of proximity of trail/road system to streams.	Genetic viability and variability of existing native aquatic biota are not reduced.	**26)** Minimize/avoid streamside trails and camps. Also follow MS 7.
Pre-Attack Facilities: Pre-Attack facilities such as fuel breaks and waterchances exist throughout the watershed. Some are in poor condition (due to lack of past maintenance or effects of recent fires) and are causing resource damage.	Pre-Attack facilities are functional and are an important part of limiting effects of catastrophic fires.	**27)** Maintain a mix of Pre-Attack facilities consistent with other resource needs and the Federal/private interface. For example, water chances constructed to maintain channel stability and fish passage.

Table 3.3
Conditions and Management Strategies within the Shrub/Steppe Vegetative Group, Entiat Analysis Area

Shrub/Steppe

Existing Condition	Desired Conditions	Management Strategies (MS)
Vegetation		
Altered Vegetative Structure & Condition - Fire: Most of area burned in Tyee and Dinkelman fires resulted in loss of much of shrub component and scattered large pines. Condition of the shrub component in these recently burned areas approximates pre-settlement conditions; whereas, unburned areas have a higher percentage of shrubs (lower percentage of grass-forb) than existed prior to pre-settlement.	There is a mix of shrub age classes, grasses and forbs associated with scattered large pines. Native ground cover capable of resisting noxious weed expansion. Plant communities produce structurally diverse, vigorous groundcover that approaches a natural grassland condition.	**28)** Replicate natural fire regimes, on a landscape scale, with low intensity underburns that promote fire resilient understory and fire tolerant overstory (minimize development of ladder fuel structures) **29)** Encourage the development of native shrubs and forbs to provide a mix of vegetative composition and structure.
Altered Vegetative Structure & Condition - Grazing: Altered vegetative community structure due to historic overgrazing with fire exclusion: decline of native perennials-->increase of annuals and noxious weeds; decline of native mid-level shrubs, especially in riparian areas. Concentration of livestock in valley bottoms has resulted in loss of vegetation and trampling of streambanks in some areas.	A structurally diverse, vigorous grassland community (natives) exists. Vegetative structure and condition in riparian areas supports fully functional riparian-channel system. Naturally appearing vegetative mosaic exists at the landscape scale.	**30)** Manage grazing levels to maintain understory plant vigor and structure in allotments. Also follow MSs 4, 28, 29, 34, 40, 44 & 64.
Wildlife		
Mule Deer Cover & Forage: There are abnormally low levels of mule deer cover & forage due to the extent of recent burns.	Deer populations and the level of mule deer cover & forage are in balance.	Follow MS 29 and work with the WDFW to balance mule deer populations with available cover & forage.

Shrub/Steppe (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Human Activities in Mule Deer Winter Range: Human activities reduce habitat effectiveness of deer winter range. Concern exists that increasing levels of winter recreation in lower Entiat mule deer winter range may be causing harrassment & displacement of wolves & deer from key habitat.	Human activities in winter are confined to corridors and have minimal impact on deer and wolves.	**31)** Direct winter recreation use to corridors through deer winter range during access management planning and implementation. Also follow MSs 7 & 16.
Grouse Populations: Sage grouse and sharp-tailed grouse are extirpated.	Areas to be managed and potential populations of these grouse are defined and managed under a Species Management Guide.	**32)** Inventory habitat and potential for these species. Develop species management plans for sharp-tailed grouse and sage grouse.
Cover for Ground-Nesting Birds: Reduced vegetation height, density, and composition resulting from grazing and fire reduces nesting cover for ground-nesting birds. Limited quality cover exposes these birds to the elements and greater predation, resulting in lowered reproductive success.	Proper forage utilization maintains sufficient cover for prolific populations of ground-nesting birds.	**33)** Promote development of more diverse structure and distribution of native shrubs and forbs over the entire landscape. Also follow MSs 6, 28 & 30.
Riparian Vegetative Structure & Condition: Vegetative structure in riparian areas is poor, with low populations of low to mid-level shrubs. Riparian areas not providing wildlife habitat near their capability--lacking the structure provided by deciduous components. Vegetative functions in buffering sediment delivery, providing shade, organic input (fines and large wood) and bank stability are degraded.	Vegetation structure in riparian areas approximates historic conditions and supports natural functions (diverse mix of low and mid-level shrubs, as well as deciduous trees)	**34)** Promote all layers of vegetative structure in riparian areas (grass, forbs, low to mid-level shrubs, trees and unique habitats). Also follow MS 2.

Shrub/Steppe (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Unique Habitat-Columbia River Breaks: The varied terrain and rocky sites in close proximity to the Columbia River add to the potential for unique habitats for plants and animals to be found within these areas. There is little current knowledge of these areas on which to draw for analysis of effects of potential management activities.	The areas are surveyed for better understanding of distribution of species and habitats. Information is available for proper management and analysis of potential management activities on these lands, the adjacent watersheds and within the province.	**35)** Complete provincial-level wildlife species guild analysis. Also follow MS 6.
Soil/Water/Fish	(Also applicable to Open Forest)	
Large Woody Debris: In this zone, large woody debris (both present and potential) is lacking in many streams, especially fish-bearing waters (Ref App F-6.2).	Vegetative structure and condition in riparian areas is restored, providing for adequate recruitment of large woody debris.	**36)** Maintain, plant or encourage large diameter native tree species in riparian reserves. Also follow MS 34.
Erosion/Sedimentation: In this zone, erosion, sediment delivery and sediment storage in channels and on floodplains are all high.	Accelerated sedimentation is reduced from existing and not adversely affecting beneficial uses.	Follow MSs 2, 5, 7, 29 & 36.
Riparian Road Density: Road densities are high in riparian areas. These roads intercept sub-surface flows, concentrate runoff, increase sedimentation, confine channel migration and reduce security and other wildlife habitat values.	Riparian habitat values and floodplain function are restored.	Follow MSs 2, 5, 7, 34 & 36.
Stream Channels: Many stream channel segments in this zone are artificially constrained & simplified by roads, development, channelization, event response structures (flood & fire rehabilitation) and other uses.	Stream channels are healthy and functioning within historic limits.	**37)** Evaluate the need to remove or modify existing BAER structures (check dams) following their effective lifespan. In developing rehab plans for future events, consider habitat connectivity and long-term, material transport processes at sites proposed for treatment. Major emphasis on coordinated resource management (MS 10).

Shrub/Steppe (continued)

Existing Condition	Desired Conditions	Management Strategies (MS)
Fish Habitat: Rearing and holding habitat, off-channel and in-channel winter rearing habitat, spawning habitat and resident adult habitat in this zone are in fair to poor condition in all stream segments.	Spawning, rearing and holding habitats are at or near their natural capabilities. Habitat connectivity is present throughout, man-made barriers to fish passage are not present, and irrigation diversions are screened or re-designed to provide habitat.	Follow MS 2. Major emphasis on coordinated resource management (MS 10).
Scenery/Recreation		
Landscape Appearance: Landscapes are mix of altered and natural-appearing.	A natural-appearing character theme and condition is present for scenic travel routes, viewsheds and recreation settings.	**38)** Manage foreground and middle ground for scenic purposes. **39)** Rehabilitate altered landscapes as shown on scenic condition map. **40)** Use scenic management system for landscape aesthetics to maintain and enhance scenic resource. **41)** Recent Decision Notices manage foreground of Potato Creek Road #5380, Baldy Mtn Road #8410, Steliko Ridge Trail and Tyee Road #5700 at a higher Visual Quality Objective (VQO) than Forest Plan indicates. Future actions will consider the appropriateness of continuing these VQOs given the extent of wildfire disturbance. Also follow MSs 13, 14 & 34.
Change of Viewshed - Road Density: Road density and/or locations present an altered appearing landscape. As a result of the Tyee fire, some roads are more visible because vegetative screening burned.	Landscape that appears more natural, roads blend in and are more subordinate to the characteristic landscape patterns. Some roads may be converted to trails. A Natural Appearing landscape character theme and scenic condition is present for scenic travel routes, viewsheds and recreation settings.	**42)** Evaluate foreground and middleground views from major and secondary travel routes. Reduce middleground views of high density roads in the following areas as viewed from major and secondary travel routes: Preston/Brennegan Creek, Mills Canyon/Roaring Ridge, Billy/Cougar Basin, Shamel/Roundy Creek, Lower Mad River, and Chumstick. Reduce views of roading by establishing vegetative screens. Roads may be converted to trails where appropriate for all ranges of ROS (Recreation Opportunity Spectrum) classes. Also follow MSs 7, 38-41.

Existing Condition	Desired Conditions	Management Strategies (MS)
Change of Viewshed - U.S. Highway 97, 97A (U.S. Highway 2) and Highway 971 - Segment of Cascade Loop Tour: Most of the viewshed is Natural Appearing, but some areas are altered through management activities in middleground areas.	A Natural Appearing landscape character theme and scenic condition is present for scenic travel routes, viewsheds and recreational settings.	**43)** Manage middleground for scenic purposes. Maintain/establish native vegetation in altered areas. Also follow MSs 11, 29, 38 & 40.
Range Uses		
Range Allotment Conditions: Prior to the Tyee Fire, most upland areas in existing allotments were in fair to good condition. Valley bottoms were in poor to very poor condition. Livestock concentration in valley bottoms is a concern. Desireable perennials are being replaced by annuals and noxious weeds in shrub/steppe and open forest areas. Many range improvements were damaged or destroyed by Tyee Fire.	Adequate ground cover is maintained to promote infiltration and reduce surface runoff. Vegetative structure and condition in riparian areas supports fully functional riparian-channel system. A diverse and vigorous assortment of well-established perennial grasses is maintained in the uplands. Noxious weed populations are confined. Range improvements are well maintained and do not promote resource damage (e.g., valley bottom concentrations).	**44)** Develop Allotment Management Plans that will: (a) Prioritize range improvement rehabilitation, (b) Identify & resolve grazing concerns (e.g., south slopes, weed prone areas, etc.), (c) Identify transitory range opportunities, (d) evaluate opportunities to realign pasture boundaries in more logical manner and (e) Identify key use areas and develop management strategy for protection, rehab, etc.. Inventory range improvement conditions and develop multi-year plan to rehabilitate priority developments. Follow FP Standards for RNA's and sensitive species management. Follow criteria for livestock reentry into Potato Creek Allotment (Appendix G-4). Use water developments to avoid negative impacts on vegetation (i.e., riparian areas, seeps and springs, sensitive areas). Also follow MSs 1, 2, 6, 8, 29, 30, 34, & 64.
Wildlife-Domestic Forage Competition: Mule deer, bighorn sheep and domestic livestock compete for existing forage. The degree of competition between them is unknown.	Permitted grazing and wildlife forage needs are in balance with proper use of forage production.	**45)** Analyze forage availability, refer to Forest Plan Standards and allocate forage use between mule deer, bighorn sheep, and domestic livestock appropriately. Season of use and varied grazing systems may be used to regulate forage use. Review Potato Creek Allotment Criteria for Livestock Reentry (Appendix G-4) and take appropriate action. Also follow MS 29.

Table 3.4
Conditions and Management Strategies within the Open Forest Vegetative Group, Entiat Analysis Area

Open Forest

Existing Condition	Desired condition	Management Strategy (MS)
Vegetation		
Altered Vegetative Structure & Condition - Recent Fires: Early and mid successional stages are predominant due to fires since 1970. Shrub component in understory greatly reduced due to recent fires; much of existing overstory is dead with the exception of occasional green clumps.	A mix of successional stages exists, providing a mosaic of vegetation. Grassland shrub understory with pine overstory 10 to 50% crown closure. Understory consists of 5 to 15% shrubs.	**46)** Manage to achieve vegetative conditions and fuel profiles/distributions that support low to moderate fire intensities and more natural frequency regime. **47)** Maintain sufficient snag, down wood and soil wood levels to meet soil productivity, wildlife and scenic needs. **48)** Utilize varied strategies that reduce the development of high stocking levels including prescribed fire, mechanical fuel treatment and harvest. Also follow MS 28.
Altered Vegetative Structure & Condition - Unburned Areas: Unburned portions of this zone have low levels of standing dead and down, high levels of standing small diameter green trees. Stocking is higher than under historic conditions and ladder fuels are high (shrub and suppressed trees.) With these fuel loadings, the potential for moderate-high intensity fires is high.	Stand structures are such that the potential for high and moderate intensity fires is low. Fuel profiles are present that support low to moderate intensity fires as opposed to high intensity, stand-replacing fires. Fire frequency closer to natural regime.	**49)** Maintain a wide spacing of park-like ponderosa pine. Thin smaller diameter trees to reduce densities. Maintain denser stands (protected by surrounding low fuel areas) on selected sites to meet other resource management objectives. Also follow MSs 28 & 46.
Altered Vegetative Structure & Condition - Grazing		See text for MS 30
Wildlife		
Mule Deer Forage and Cover: There is a shortage of both forage and cover areas for deer.	Clumps of coniferous trees providing cover and open foraging areas are present and well distributed.	**50)** Manage stands of thermal cover on strategically selected sustainable sites. Also follow MSs 28 & 29.

Open Forest (continued)

Existing Condition	Desired condition	Management Strategy (MS)
Human Activities in Mule Deer Winter Range		See text for MS 31
Unique Habitat-Columbia River Breaks		See text for MS 35
Riparian Vegetative Structure & Condition		See text for MS 34
Soil/Water/Fish		
See Existing Conditions for Shrub/Steppe.	See Desired Conditions for Shrub/Steppe.	See Management Strategies for Shrub/Steppe.
Scenery/Recreation		
Landscape Appearance: Some of the landscape is in an altered condition as shown on the scenic condition map.	Landscape is natural appearing.	Follow MSs 13, 14, 34, 38-41.
Change of Viewshed-Road Density		See text for MS 42
Change of Viewshed - U.S. Highway 97, 97A (U.S. Highway 2) and Highway 971 - Segment of Cascade Loop Tour		See text for MS 43
Recreation Facilities Protection: Large woody debris build-ups in the riparian zone of the Mad River pose a threat to adjacent recreation facilities.	Provide adequate large woody debris to maintain habitat that does not threaten recreation facilities along the Mad River.	**51)** Selectively remove or reposition large woody debris to maintain habitat and protect recreation facilities. Relocate facilities where appropriate. Also follow MSs 2 & 16.
Range Uses		
Range Allotment Conditions		See text for MS 44
Wildlife-Domestic Forage Competition		See text for MS 45
Cover for Ground-nesting Birds		See text for MS 33

Table 3.5
Conditions and Management Strategies within the Closed Forest Vegetative Group, Entiat Analysis Area

Closed Forest

Existing Condition	Desired Condition	Management Strategy (MS)
Vegetation		
Successional Stages: Disproportionate amounts of early successional stage exist due to large fires since 1970. Unburned portions of zone are predominantly mid-successional and higher in density than under historic conditions. Unburned, higher elevation portion of zone is providing excellent spotted owl habitat. (late successional stage with multi-layered grand fir understory)	Areas of open grown, park-like ponderosa pine are present with interspersed mosaic of early-mid-late successional stages, as needed to meet resource requirements. For example, a mosaic of successional stages throughout the higher elevation portion of the zone (at roughly 1/3 of each structural stage) should exist for spotted owl habitat.	**52)** In reforestation, favor ponderosa pine widely spaced in lower elevations of zone and dry sites; favor Douglas-fir over grand fir in higher elevation, mixed conifer, moist sites. **53)** Protect remaining green stands (late successional) and manage entire zone to achieve a mosaic of successional stages, arranged in a natural functioning & appearing mosaic (Further analysis needed to evaluate ability to create 1/3 mosaic, especially in the short-term, within existing constraints (e.g., LSRs). **54)** Manage stocking levels in green stands to favor larger diameter, wider tree spacings where owl habitat is not a primary consideration (ponderosa pine in drier areas, Douglas-fir in more moist sites). Also follow MSs 15, 46 & 47.
Fuel Loading: This zone contains a high density of smaller-diameter, standing dead trees. Unburned sites are also characterized by relatively high fuel loadings.	Fuel profiles are characteristic of low-moderate fire intensity instead of supporting high intensity, stand replacing fires. Fire frequency closer to natural regime. Defensible space is maintained around structures.	Follow MSs 46 & 47
Large Diameter Trees: There is a shortage of large diameter trees (> 20 inches dbh) due to past fires or timber harvest in the unburned portions of zone. Those present have low levels of cavities suitable for wildlife.	Large trees are present, many having defect characteristics that support cavity development.	**55)** Maintain existing and favor growing large diameter trees. Also follow MSs 54 & 58.

Closed Forest (continued)

Existing Condition	Desired Condition	Management Strategy (MS)
Wildlife		
Carnivore Habitat Limitations: Habitat is limited for native species such as fisher, wolverine, wolf, marten and lynx.	Native animal species are present. Habitat supports viable population levels. Road densities are less than 1 mile per square mile.	**56)** Maintain high density down wood concentrations for native species. Also follow MSs 7 & 53 within existing constraints (e.g., LSRs).
Human Activities in Mule Deer Winter Range		See text for MS 31
Soil/Water/Fish		
Existing Debris Slides: Debris slides and channels have formed as a result of fire-flood events.	Old debris channels are undisturbed; surface runoff is not concentrated as a result of human activity. Channels and riparian corridors are in a condition to accomodate natural hillslope functions.	**57)** Avoid road locations or other managment disturbances in and tributary to old debris channels and in areas of high mass wasting hazard.
Large Woody Debris: Approximately 50% of surveyed stream reaches in this zone do not meet Forest Plan standards for large woody debris.	Large woody debris (LWD) is present at Forest Plan standards in all stream reaches. Debris jams and step pool profiles approximate historic conditions. LWD recruitment is at the appropriate, sustainable level for the vegetative type and site conditions.	**58)** Avoid removal of trees larger than 20 inches dbh from riparian reserves. (especially on class I to III waters). **59)** Where appropriate, change Forest Plan standards to be in line with natural capability. Also follow MSs 2 & 36.
Primary Pools: Less than 25% of surveyed stream reaches have large pools that meet Forest Plan standards.	Deep pools exist that meet Forest Plan standards with adequate cover and well vegetated banks.	Follow MSs 2, 34, 36, 58 & 59.
Aquatic Habitat Diversity: Riffle habitat dominates most reaches, but diversity is provided by small pools formed by large woody debris.	Habitat complexity provides for all life stages of all native aquatic species.	Follow MSs 2, 34 & 59.

Closed Forest (continued)

Existing Condition	Desired Condition	Management Strategy (MS)
Scenery/Recreation		
Landscape Appearance: The zone consists of a mix of natural appearing and altered landscapes.	Landscapes are natural appearing and consist of a diverse composition of plants and age classes including large (> 20 inch dbh) trees.	**60)** Re-establish and/or maintain western larch where adapted & appropriate. Also follow MSs 13, 14, 38-41, 53 & 55.
Change of Viewshed - Road Density		See text for MS 42
Recreation Facilities Protection		See text for MS 51
Range Uses		
Range Allotment Conditions		See text for MS 44
Wildlife-Domestic Forage Competition		See text for MS 45
Cover for Ground-Nesting Birds		See text for MS 33

Table 3.6
Conditions and Management Strategies within the Closed Subalpine Vegetative Group, Entiat Analysis Area

Closed Subalpine

Existing Condition	Desired Condition	Management Strategy (MS)
Vegetation		
Successional Stage: Vegetation is predominantly mid and late successional stage with mid successional often comprised of mature lodgepole pine overstory. In such cases stands are typically dense with > 1000 stems per acre. High numbers of snags and down woody debris < 20 inches dbh.	Zone is made up of a mosaic of vegetative conditions with most stands in mid-late stage.	Follow MS 53 to favor lynx habitat where appropriate.
Wildlife		
Carnivore Habitat Limitations		See text for MS 56
Soil/Water/Fish	(Also applies to Open Subalpine)	
Groundwater Interception: Management activities, primarily roads, have intercepted near-surface groundwater, especially in the Cougar and Lake Creek areas (LTAs C & B).	Subsurface flow interception and runoff concentration from existing facilities is reduced. Additional disruptions of near-surface groundwater movement are minimized.	**61)** Existing and planned road & trail locations and drainage structures need to be improved/ planned to account for high levels of near-surface groundwater storage and flow in these soils. Also follow MSs 5 & 7.
Stream Channel Confinement: Some stream channel segments are constrained by roads and riparian function (sediment buffering) is impaired.	Floodplains are fully functional and streamflows are well regulated over the entire year. Maximize storage of subsurface flows as near surface ground water.	Follow MSs 2-4, 7, 34 & 61.
Primary Pools: Less than 25% of surveyed stream reaches meet Forest Plan standards for primary pools.	Pools exist within the ecological capability of the site. In this case pool occurrence is partially limited by high gradient reaches. Existing Forest Plan standards are not achievable.	Follow MS 59.

Closed Subalpine (continued)

Existing Condition	Desired Condition	Management Strategy (MS)
Fish Habitat Condition: Rearing and holding habitat, off-channel winter rearing habitat, in-channel winter rearing habitat and spawning habitat are in fair to good condition.	Substrate fines are acceptable for bull trout spawning and other aquatic organisms (<20% fines of <1.0mm diameter).	Follow MSs 2, 5, 34 & 36.
Scenery/Recreation		
Landscape Appearance: Natural Appearing landscape	Natural Appearing landscape	Follow MSs 38, 40 & 41.

Table 3.7
Conditions and Management Strategies within the Open Subalpine Vegetative Group, Entiat Analysis Area

Open Subalpine

Existing Condition	Desired Condition	Management Strategy (MS)
Vegetation		
Meadow Succession: Some conifer encroachment of meadows exists, forested areas are mostly late successional. Encroachment is escalating in some "significant" meadows that provide special recreation experiences. They are special places for people.	There is a naturally appearing mosaic of meadows and conifer patches.	**62)** Inventory, analyze & evaluate site specific conditions and develop integrated meadow plan. Identifiy conditions which maintained meadows naturally and how to best restore desired openings. Implement restoration of "significant" meadows low intensity underburns or mechanical/manual treatments to retard or reverse conifer encroachment. Emphasize appropriate fire suppression response while considering maintaining a natural appearing vegetative mosaic. Also follow MS 11.
Whitebark Pine: Whitebark pine is infested with blister rust.	Healthy whitebark pine is an important component of forested landscape, providing food and cover for a varitey of birds and mammals.	**63)** Evaluate appropriate options for preserving WB pine stands through disease resistant stock (genetic resistance to blister rust). Also follow MS 62.
Sheep Grazing Effects: Past sheep grazing has caused vegetative changes including more bare areas and reduced forb component.	Meadows and open areas consist of 4-inch to 12-inch mix of shrubs forbs and grasses. Meadows occupy their historic niche.	**64)** Complete limit of acceptable change analysis and include assessment of past sheep grazing. Implement restoration work as appropriate.
Wildlife		
Zone Composition: Zone consists of a mixture of meadows, forested clumps and nonvegetated rocky areas. There are localized impacts from past grazing and human use.	Natural characteristics of open subalpine landscape	Maintain existing condition. Restore sites of localized impacts where feasible. Also follow MSs 29 & 62.
Soil/Water/Fish		
See Existing Conditions for Closed Subalpine.	See Desired Conditions for Closed Subalpine.	See Managment Strategies for Closed Subalpine.
Scenery/Recreation		
Landscape Appearance: Natural Appearing landscape.	Natural Appearing landscape.	Follow MS 62 to maintain natural appearing conditions.

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CHAPTER 4

STEP 8: Information, Monitoring and Revision

This section provides guidance on monitoring and identifies additional inventories and analyses needed to carry forward into future iterations. This section reflects the importance of the quality of the data available to perform watershed analysis. Recommended priorities for implementation of monitoring activities and follow-up actions are presented in Chapter 5.

Monitoring & Evaluation

A formal monitoring plan for the Entiat Analysis Area will be developed as a follow-up action to this watershed assessment. This effort should emphasize coordination with other stakeholders in the watershed, especially through the Coordinated Resource Management Plan being developed with the Chelan County Conservation District.

The following recommendations provide guidance for development of a coordinated monitoring plan. The plan will incorporate monitoring direction within the WNF LRMP and the ROD for the Northwest Forest Plan (Aquatic Conservation Strategy). Emphasis must be placed on monitoring of priority issues on a representative basis (sub-sampling). The level and intensity of the monitoring effort will vary based on the scope and sensitivity of the issue.

Vegetation

1) Existing condition and trends in vegetative structure & condition - Broad stand exam/vegetation condition surveys in unburned and partially burned areas; Monitor vegetation succession in various plant associations by burn intensity

2) Inventory and monitor plant species of concern - noxious weeds, sensitive plants. Emphasis on noxious weed trend in the fire area. Monitor response of known rare plant populations to fire

3) Vegetative recovery in riparian areas.

4) Analysis and monitoring of forage/cover availability

5) Inventory and monitor fungal populations in the fire area.

6) Conduct before/after stand exams in a sub-sample of areas within which Tyee recovery projects (e.g., chipping, salvage etc.) are planned. Sample all burn intensities within each vegetative group. Utilize R6 Intensive stand exam procedure, including characterization of fuel loadings.

7) Emergency Burned Area Rehab seeding and native plant recovery response -
Establish and periodically read vegetative plots both in and out of areas treated with erosion control grass seed mixes in both the Dinkleman and Tyee Fire areas. Sample all burn intensities within each vegetative group. Utilize a sampling procedure including soil profile analysis. Address questions related to seed take, re-establishement of ground cover and species diversity in plant community in response to differest burn intensities and treatments.

Wildlife

1) Monitor grass/forb/shrub/trees within the deer winter range to evaluate cover and forage conditions. Monitor deer numbers, distribution and human activities in winter in coordination with the Washington Department of Fish and Wildlife to evaluate the condition of wintering habitat and deer populations.

2) Monitor riparian vegetation for recovery and the need for habitat improvements. Management indicators are hardwood vegetation, beaver, ruffed grouse, noxious weeds, roads and grass/forb edge.

3) Monitor impacts from human activities, especially road influence zones (i.e., roads, trails, campgrounds private lands, dispersed camping, etc.,).

4) Monitor bighorn sheep, Columbia sharp-tailed grouse and sage grouse use in coordination with Washington Department of Fish and Wildlife.

5) Inventory unique, critical and key wildlife habitats (e.g., winter range); Monitor effect of management on these habitats and species use.

6) Inventory & monitor T&E species (grizzly, bald eagle, peregrines, wolves, spotted owl), MIS species and Survey and Manage species and Sensitive Species (e.g., Swakane Bighorn sheep population), as per WNF & NW Forest Plan direction; Attempt to determine where owls displaced by the fire have re-established use.

7) Monitor Late Successional Reserves (LSRs) for compliance with the Northwest Forest Plan goals.

8) Monitor snag numbers, snag fall rates and down woody debris trends following wildfire.

9) Survey likely habitats for "survey and manage" species from the ROD of the Northwest Forest Plan and manage habitats to conserve populations found. Monitor those habitats, areas and populations for compliance and effectiveness.

Soil/Water/Fish

1) Establish and maintain an early warning (ALERT) system for flood forecasting in cooperation with with the National Weather Service, Chelan County Department of Emergency Services and other local agencies. Co-locate new snow courses with ALERT weather station sites within the burned area. Multi-finance full-time staffing at the Sugarloaf and Tyee Mountain Lookouts as part of this early warning system. ALERT stations to be established recognizing precipitation/elevation zones within the fire area. **Status:** Done in 1995.

2) Incorporate on-going monitoring activities into the coordinated plan:

a) Continue to compile and annually evaluate fish resource information available from other agencies (e.g., WDFW redd surveys, dam counts, etc.) **Status:** Done in 1995; On-going.

b) Continue annual Mad River bull trout spawning monitoring. **Status:** Done in 1995; On-going.

c) Maintain and consider expanding the streambed core sampling work being done in the mainstem Entiat (McNeil core sampling) to better characterize fine sediment deposition in the subbasin. Expansion of this effort may involve both addition of sites and increase in sample size at existing sites to improve statistical reliability of results. **Status:** Done in 1995; On-going.

d) Continue riparian and channel condition inventories (stream surveys) at the recommended five-year repeat interval. **Status:** Done in 1995-Mad River, Young Creek, and Billy Creek; On-going.

e) Continue and expand annual stream temperature monitoring. Future iterations of watershed analysis will examine water temperature as limiting factor to fish. The current data base shows much variation in the extent, duration, and location of summertime highs. It is suspected that wintertime lows and the formation of anchor ice in the lower mainstem Entiat and Mad Rivers may be more of a limiting factor than summertime highs. **Status:** Done in 1995; On-going.

f) Continue effectiveness evaluation of watershed restoration projects (road closures, crossing rehabilitation, cut and fill slope erosion, and revegetation, etc.) **Status:** On-going.

3) Initiate the following actions related to water quality/quantity monitoring:

a) Establish and maintain cooperative agreement with the U.S.G.S. regarding the operation of a telemetry platform on the active stream gage on the Entiat (Entiat at Ardenvoir). **Status:** Done in 1995.

b) Coordinate with USGS on establishment and maintenance of continuous record stream gages near the mouths of the Entiat and Mad Rivers. **Status:** Done on 3/96 for Entiat River.

c) Evaluate monitoring needs for water quality parameters (sediment, nitrates, phosphates, etc.) with the WA Department of Ecology and USGS. **Status:** On-going water quality monitoring since 4/95.

4) Evaluate need for and establish representative reaches with surveyed channel cross sections to document condition/trend in aquatic habitat in critical areas over time. **Status:** NRCS Stream Team evaluated lower 20 miles 9/95; permanent surveyed transects established.

5) Implement the Burned Area Emergency Rehabilitation (BAER) Monitoring Plan developed to evaluate recovery in the fire area and the implementation and effectiveness of BAER measures. **Status:** On-going qualitative.

6) Complete soil-disturbance standard compliance monitoring for any new ground-disturbing activities, with special focus on open forest and closed forest types. **Status:** Done in 1995; On-going. Implement method to evaluate recovery in areas with residual impacts.

7) Road management activities (e.g., use impacts, maintenance needs, closure effectiveness). **Status:** On-going

8) Initiate background soil moisture and infiltration rate data collection and monitoring. **Status:** Soil moisture blocks installed 1995.

Scenery/Recreation

1) Tyee Fire recovery projects for scenic integrity levels and landscape character

2) Impacts from recreation use, on facilities and resources, especially in developed sites and dispersed sites outside of wilderness.

Range Resources

1) Post-fire recovery of Potato Creek Range Allotment (Recovery criteria for soil, vegetation and riparian areas; range improvement conditions).

2) Forage utilization levels in active commercial grazing allotments.

Follow-Up Actions to this Assessment

During the preparation of both iterations of this assessment, a number of information needs were identified. These needs relate to both the issues addressed in these analyses (see Chapter 1) and those to be addressed in more detail in future iterations. Follow-up actions and data needs related to monitoring are identified in the previous section. This section focuses on information needs for future analyses in the area. Emphasis is placed on refining the analysis of existing data and the collection of new data for high priority resource inventories. These actions are directed at completing future assessments and site-specific analyses at a more rigorous level.

Vegetation

1) Conduct stand exam in a sub-sample of Dinkelman and Tyee Fire areas to provide more detailed information on plant communities within these areas. Include exams in riparian areas and LSRs to help refine reserves in the Northwest Forest plan. Sample all burn intensities within each vegetative group. Utilize R6 Intensive stand exam procedure, including characterization of fuel loadings and dead tree fall rates.

2) Establish a set of stand exam plots in and adjacent to salvage units in the Dinkleman and 1970 fire areas. Address questions related to condition of regeneration, snag population, down material and fuel loading, plant diversity and site potential change due to canopy removal.

3) Conduct vegetative mapping in unburned areas to determine actual successional stage, structure and vegetative type.

4) Develop an ecotype layer in GIS. Determine if this layer can be used to improve the characterization of plant community structure.

5) Develop a data base--with existing high quality stand exam data--that could be used in combination with the ecotype layer to improve characterization of plant community composition and structure.

6) Evaluate the need for more active managament in the open subalpine group, directed at maintenance of meadow environments.

Wildlife

The following inventories and analyses are necessary to continue the progress made in this watershed assessment. These actions recognize that wildlife issues are often not fully resolvable at the watershed level without analysis across watersheds at the province level.

1) **Province Analysis:** Complete province-level framework needed to support habitat and population analysis at the watershed level. Components of this province-level analysis include the following:

a) Complete and implement inventory/analysis procedure that describes vegetative **structural components** at the level of detail necessary to fully support wildlife analysis. Structural descriptions from current vegetative data base are insufficient. Structural components would include grass/forb, shrub, live/dead tree, down material, and "other" (e.g., rock, cliffs, bare ground, etc.).
b) Complete descriptions of wildlife guilds--what they look like and how they function (Shrub/Steppe, Open Forest, Low Elevation Early/Mid/Late, Mixed Conifer Early/Mid/Late, High Elevation Early/Mid/Late, and Riparian Early/Mid/Late).
c) As province level work is completed, review watershed analyses done to date to evaluate needs and priorities for refinement based on the improved description of the "big picture". Analysis of the spatial arrangement and connectivity of landscapes will be enhanced with these refinements.
d) Finalize descriptions of the structure and function of special and unique habitats. Inventory and map special and unique wildlife habitats (e.g., wetlands, springs, guzzlers, seeps, wallows, rocky terrain, etc.).

2) **Threatened and Endangered Species**: Complete habitat structure/function descriptions for northern spotted owl and grizzly bear. Inventory potential nest sites for peregrine falcon to be incorporated into an inventory of special and unique habitats (rocky terrain). Habitat descriptions for bald eagle, peregrine falcon, and gray wolf are complete.

3) **Sensitive Species:** Complete habitat structure/function descriptions for sensitive species. A province-level plan and inventories are needed for several of these species.

a) California Wolverine - Need description
b) North American Lynx - Need description; Inventory lynx habitat and determine presence
c) Pacific Fisher - Need description
d) Townsend's Big-Eared Bat and Spotted Bat - Need description
e) Bighorn Sheep - Description completed; Evaluate viability issue surrounding domestic grazing
f) NW Pond Turtle, Spotted Frog, Northern Red-Legged Frog, Cascades Frog and Larch Mountain Salamander - Need descriptions and inventory
g) Harlequin Duck - Need description
h) Long-billed Curlew
i) White-Headed Woodpecker - Completed via Primary Cavity Excavator description
j) Northern Goshawk - Need description
k) Flammulated Owl - Description completed
l) Western Sage Grouse, Columbia Sharp-Tailed Grouse - Description completed
m) Mountain Quail - Need description and inventory
n) Loggerhead Shrike, Black Tern, Upland Sandpiper - Need descriptions and inventories
o) Ferruginous Hawk - Need description
p) Swainson's Hawk

4) **Management Indicator Species** - Complete habitat structure/function descriptions for Management Indicator Species.

a) Pine Marten - Need description
b) Mountain Goat - Need description
c) Mule Deer Winter Range - Description complete; need evaluation of animal movement and human access
d) Primary Cavity Excavators (PCE) - Descriptions complete; Inventory and map snags and dead/down tree potential populations for primary cavity excavators (inventory types are Open Forest, Closed Forest and Subalpine Forest)
e) Northern Spotted Owl
f) Pileated Woodpecker - Incorporated into PCE habitat
g) Northern 3-Toed Woodpecker - Incorporated into PCE habitat
h) Beaver/Ruffed Grouse - Incorporated in riparian guild description

5) **Inventory Summary:** In the work listed above, habitat inventories are needed for a number of species and habitats to fill critical information gaps for future watershed and project analyses. The following list of needed inventories is provided to help guide data collection efforts. Those species flagged with an asteric (*) are also "survey and manage" species.

	a)	Amphibians - presence and habitat
*	b)	Spotted Owl - presence (survival) and habitat
	c)	Peregrine Falcon - potential nest sites
*	d)	North American Lynx - habitat and presence
	e)	Fisher, Marten, Wolverine - presence & habitat if present
*	f)	Townsend's Big-eared and Spotted Bats - presence and habitat
	g)	Harlequin Duck - presence and habitat
*	h)	White-headed Woodpecker - presence and habitat
*	i)	Pygmy nuthatch - presence and habitat
*	j)	Flammulated Owl - presence and habitat
	k)	Loggerhead Shrike - presence and habitat
	l)	Ferruginous Hawk - presence and potential nest sites
*	m)	Northern Three-toed and Black-backed Woodpecker - presence
	n)	Beaver - monitor habitat recovery
	o)	Snag/log density by size and timber series

6) **Survey & Manage Species**: Inventory for appropriate "survey and manage species" as identified in the Northwest Forest Plan, as follows.

a) Larch Mountain Salamander
b) Great Gray Owl
c) Chelan Mountainsnail
d) Warty Jumping Slug
e) Blue-gray Taildropper
f) Papilose Taildropper
g) Washington Duskysnail
h) Pallid and Silver-haired Bats
i) Long-eared and Long-legged Myotis

Additional species with an asterisk (*) listed above, in inventory needs, are also "survey and manage" species.

7) **Snag and Down Material Use**: Promote data collection/research on snag and dead/down material use and decay rates.

8) Survey non-forested as well as forested environments to better identify all wildlife and communities within the watershed, and to get a better picture of habitat needs, species status and distribution.

Soil/Water/Fish

1) Based on monitoring feedback, maintain existing BAER treatments and install additional treatments needed to accelerate restoration of the Tyee Fire area. Continue to support public education regarding fire/flood scenario in Entiat subbasin. **Status:** On-going since 1994 event.

2) Continue cooperative work with the public, Chelan County Conservation District and other agencies in developing a Cooperative Watershed Management Plan for the Entiat. **Status:** On-going; began synthesis 3/96.

3) Encourage a stream survey of privately-owned lower Entiat River for comparison to 1930's Bureau of Fisheries surveys. Such a survey would complete the survey coverage of the entire mainstem Entiat and would provide information for addressing natural range of variability questions on the key habitat in the system. **Status:** Done in 1995 - NRCS Stream Team surveyed lower 20 miles of mainstem Entiat.

4) Complete an annotated summary of historic data available through the Barometer Watershed, Entiat Experimental Forest and other studies/surveys in the Entiat subbasin. Develop PC-based data tables for selected parameters needed in subsequent watershed and project analyses.

a) Include assembly of historic photographic record and retake photos for comparative purposes as possible (e.g., panoramic series from area lookouts). Complete a times-series photo analysis to document and evaluate channel change in the river corridor. **Status:** Begun in 1995.

b) Complete a GPS-tagged, videotape recon of the River corridor and selected tributaries for use in project and watershed analyses. **Status:** Done in 1995.

5) Complete a sediment yield analysis for the subbasin, incorporating fire effects and information being assembled on past management activities. Address questions related to potential impacts of altered yields on beneficial uses, habitat structure (pool characteristics) and instream flow analysis. Include a point inventory of surface and mass erosion sites within the fire area. Utilize opportunities to measure material collected behind check dams for estimates of yield. Address questions relating to effects of surface erosion and sediment transportation processes on hillslope vegetation characteristics. Evaluate need and procedure for qualitative and quantitative monitoring of surface erosion and sediment transport processes in deposition zone.

6) Coordinate with other agencies on water yield analysis for the subbasin. Address questions related to fire and past management effects on flow regime and the stage of hydrologic recovery. Address possible effects of reduced flow, as a result of water diversions (historic and present).

7) Collect and analyze historic stream temperature data (FS archives, WaDOE, Yakama Tribe, USFWS Hatchery, etc.) for use in project and watershed level analyses. Address questions relating to temperature limitations to fish in the subbasin.

8) Initiate cooperative spring spawning surveys (steelhead).

9) Evaluate options and implement a quantitative method for measuring fine sediment deposition in 3rd to 5th order channels in the Entiat (e.g., hoop embeddedness, pebble counts, etc.) in order to better characterize fine sediment deposition in the tributaries. **Status:** Begun in 1995 (Mad River); On-going.

10) Initiate a field "study" to evaluate if historic management actions have reduced soil productivity in the shrub/steppe and open forest vegetative groups, which would limit desired vegetative conditions. This is focused primarily on the assertion that historic over-grazing resulted in a loss of topsoil that favored tree establishment as opposed to grass/forb communities. Include a thorough literature search and field evaluation of exclosures and other non-grazed areas.

11) Initiate a field "study" to evaluate the impacts of the recent high intensity burn on soils in the open forest. Specifically, how has soil productivity been impacted by a fire that resulted in intensities atypical of this vegetative group (Naturally, 90 percent L-M and 10 percent H; Tyee Fire 15 percent L-M and 85 percent H).

12) Continue refinement of a "historic" or "potential" vegetation map for the Entiat using vegetative information from the Cashmere Mountain Soil Survey. **Status:** Done in 1995.

13) Improve meadows, rock slope, wetlands and other unique habitat inventory based on compilation of existing data, model development and ground truthing.

14) Complete the Access Travel Management (ATM) analysis begun for the Entiat in 1992.

15) Investigate appropriateness and feasibility of mainstem habitat improvements, such as: (a) rejuvenating Fox Creek spawning channel by inlet re-orientation and increasing flow and (b) bypassing Entiat Falls with a fish ladder.

16) Continue road inventory, initially focusing on conditions within the burned area, using 1992-1993 data as a base.

17) Complete landtype mapping and project watershed identification for the entire subbasin. **Status:** Mad River in 1995-1996.

18) Research Coordination - Continue close coordination with Forest Service Research on priority topics (e.g., disturbance histories, snag and log studies, etc.). Explore opportunities to re-initiate studies in the Entiat Experimental Forest.

Potential Forest Plan Amendments

The following items were identified as potential Forest plan amendments during this analysis:

1) Need to evaluate appropriateness of managing foreground along Potato Creek Road (#5380), Baldy Mtn Road (#8410), Steliko Ridge Trail and Tyee Road (#5700) at a higher Visual Quality Objective level than indicated in the Forest Plan (Refer to MS 41 in Table 3.3 and Scenery Appendix).

2) Evaluate the need to reduce Forest Plan stocking level (150 trees per acre) to lower levels, based on site potential of that vegetative group (Refer to Vegetation section in Chapter 2 and Vegetation Appendix).

3) Evaluate application of more restrictive Forest Plan standard for fine sediment in key bull trout habitat (< 15%).

4) Evaluate the need to refine other Forest Plan riparian standards for large woody debris and related channel characteristics to reflect site potential (Refer to Soil/Water/Fish Appendix F). In this watershed analysis, several situations have been identified in which existing conditions appear to violate one or more of the measureable riparian standards in the Wenatchee Forest Plan. When this is the case, the Forest Plan also provides direction for evaluation as follows:

> "When existing conditions do not meet one or more measureable Forest Plan standard...
>
> a) Conduct an analysis as to why a subwatershed does not meet the standard(s).
> b) Based on results of this analysis, take one of the following actions:
> (1) If standard is not being met due to human activity, develop a strategy and timeframe to achieve the standard.
> (2) If human activities have altered a subwatershed so that it is unlikely that a standard can ever be achieved, develop a new standard for that area.
> (3) If a standard cannot be achieved due to natural conditions, develop a new standard for that subwatershed."

The original numeric standards for riparian areas in the Wenatchee Forest Plan were obtained from broad, Regional recommendations developed in cooperation with the tribes. This watershed assessment has recognized uncertainties around some parameters, such as, our knowledge regarding the natural range of variability of fine sediments or the capability of a given vegetative type to produce large woody debris meeting Forest Plan standards. A Forestwide strategy needs to be developed to deal with these issues.

Revision and Deferred Items

This document presents the results of both the first and second iterations of watershed analysis for the Entiat Analysis Area. The findings in this assessment are applicable to all National Forest System and Bureau of Land Management lands within the Entiat and Mad River key watersheds and adjacent Columbia River Tributaries.

These analyses were completed using existing information and will be amended incrementally as new information becomes available. Revision of this second iteration will be scheduled in response to new direction and/or compilation of a significant amount of supplemental data. This analysis was completed with recognition that many additional issues will be addressed by the parallel work being conducted by the Chelan County Conservation District through the Entiat Coordinated Resource Management Planning effort.

The following list summarizes the status of assessment needs identified during both the Version 1.0 and Version 2.0 analyses. Version 1.0 identified several items (recreational stock grazing, Outfitter and Guide capacity, removal of BAER structures, and native fish reintroductions) that were subsequently determined to be project-level analysis needs rather than watershed assessment needs. Accordingly, they have been deleted from the following list.

* **Range**-related issues were not fully considered in Version 1.0. Version 2.0 has addressed range uses at the watershed analysis level.

* **Social analysis and public expectations** have not been fully addressed in either iteration. Version 2.0 does incorporate some social analysis in the process of considering range and recreation uses. Social analysis and public expectations are critical for developing desired future conditions from desired ecological conditions. Until the social modules can be completed, this type of information will be gathered from the public involvement phase of the NEPA process.

* Version 1.0 did not consider **recreation**, other than rehabilitation of developed sites. Version 2.0 has addressed recreation issues at the watershed analysis level.

* **Province level analysis for wildlife** has not yet been done. Information from a province level analysis is needed for an overview of habitat and population distributions to better understand contiguity of habitats and how and where specific populations or groups of species can best be managed. This watershed assessment is subject to change based on the results of a Forest-wide wildlife province level analysis.

CHAPTER 5

RECOMMENDED PRIORITIES
Entiat Analysis Area

This chapter provides information on management priorities for the analysis area, as recommended by the interdisciplinary team for Version 2.0. These recommendations are meant as a guide to further planning and implementation of site-specific actions. These recommendations apply to the Entiat and Mad River watersheds and adjacent lands, referred to as the Columbia River Tributaries, on the Entiat and Chelan Ranger Districts.

The overall goal is for the Entiat Analysis Area, including hillslopes, riparian zones and stream channels, to be in a state of dynamic equilibrium such that these watershed components function properly, are stable and are resilient to a range of natural events. In this context and that of the NW Forest Plan, the maintenance/restoration of **properly functioning watersheds** is one and the same with the maintenance/restoration of sustainable plant communities, aquatic habitat, wildlife habitat and landscape condition. A primary element in meeting resource objectives is for vegetative conditions, in most cases, to fall within the natural range of variability (see NRV on page 11). The **key watershed** designation for the Entiat and Mad River watersheds highlights the need for restoration and maintenance of ecosystem function in this area.

Implementation of Management Strategies

In the final stage of the Version 2.0 assessment, the team reiterated those ecosystem components within the analysis area that are high priorities for maintenance or restoration (Table 5.1). The primary management strategies associated with each of these components were identified. These management priorities in Table 5.1 will be used to focus the development of site-specific actions within the analysis area.

Geographic Priorities for Management Strategies

Broad geographic priorities are established within the structure of this analysis. The tables in Chapter 3 outline management strategies for the five vegetative groups in the analysis area. These strategies range from being applicable, to some degree, in all vegetative groups (e.g., riparian function) to very specific to a particular group (e.g., alpine meadow succession). In addition, during the analysis, findings were assembled by each of the smaller resource teams based on a physical stratification of the analysis area (e.g., depositional, transitional and transport zones for Soil/Water/Fish).

Watershed restoration needs exist throughout the analysis area. Ecosystem function is degraded at these sites to varying degrees, depending on the location and magnitude of disturbance and the sensitivity of the area. The goal is to fully restore or establish an improving trend at degraded locations, based on the desired ecological conditions identified in the Management Strategy tables in Chapter 3 and those derived from subsequent site-specific analyses. The priorities for development of restoration projects are reflected in Table 5.1 (Management Strategy Priorities). Initial emphasis will be placed on the following categories of projects: (a) burned area recovery, (b) projects that move landscape toward a more resilient condition better able to handle perturbations or withstand wildfire and insect/disease epidemics and (c) access manangement projects designed to improve surface water control, reduce accelerated erosion/sedimentation, increase wildlife security and reduce maintenance costs. Appendix J provides a list of specific restoration projects proposed to date that respond to the priorities in this Assessment. This list is not exhaustive, but rather provides a sense of the range and scale of potential projects.

Table 5.1
Management Strategy Priorities - Entiat Analysis Area *

Maintenance/Restoration Priorities	Management Strategies
Restoration of sustainable forest conditions in balance with disturbance regimes: *Improve sustainability of vegetative components *Reduce fuel loadings, especially in urban interface *Revegetation of Tyee Fire area (trees & understory) *Promote natural balance of snags & down woody debris *Maintenance of large diameter trees *Reduce the chance & size of catastrophic wildfires	3-5, 9-11, 15, 28-30, 33, 35, 44-49, 52-57, 60, 62, 63, 64
Maintenance-restoration of a sustainable landscape that appears natural: *Maintenance of diverse, vegetative mosaic *Consideration of human uses of landscape *Maintain connectivity of habitat	7, 10, 11, 13-15, 17, 18, 23, 28-30, 38-43, 46-49, 52-55, 60, 62
Maintenance-restoration of riparian area function: *Restoration of vegetative condition & structure *Improve/re-locate facilities to reduce resource impacts	1, 2-7, 18-20, 26, 34, 36, 37, 44, 51, 58, 59
Maintenance of native plant communities: *Control of noxious weeds *Maintain sensitive plant populations *Improve plant community sustainability	8, 9, 20, 30, 44
Improvement of transportation system management: *Maintain access while reducing resource impacts (maintenance, use management, re-location) *Reduce road density, especially in riparian areas & specified wildlife habitats (wildlife security areas)	2, 4-7, 16, 23, 31, 42, 57, 61
Maintenance-restoration of wildlife habitat: *Recover forage species in mule deer winter range *Provide sustainable habitat components for all native species	6, 15, 25, 29-35, 45, 47, 50, 53-56, 59
Maintenance-restoration of soil productivity: *Improve degraded sites (historic grazing, harvest entries, recreation use) *Maintain acceptable productivity in areas of new disturbance	3, 4, 17-21, 27, 30,44, 47, 62

* - The order of listing in Table 5.1 is not intended to reflect priority among the components identified. The management strategies listed with each item are the primary ones associated with that particular need. All of the priorities listed above inter-relate. All of the possible inter-relationships between management strategies are not reflected in this table.

Watershed assessment is intended to develop the scientific basis for managing the ecosystem in the analysis area--not to establish a complete, site-specific program of projects. Specific priorities for maintenance or restoration actions will result from interdisciplinary integration of key findings within the analysis--at the next planning level.

This integration of resource needs is a critical step toward insuring that the correct action is being taken in the proper location. Trade-offs must be evaluated when a project proposed to meet one set of objectives poses risks to the attainment of other objectives. Resource information assembled at the watershed analysis level can be used to evaluate geographic priorities. For example, from this analysis, fish species distribution maps can be used in combination with other data or map layers (e.g., road density, landtype responses) to prioritize watershed restoration work as well as to identify appropriate management intensity in subwatersheds. In the examples described in Appendix F-8, this type of evaluation highlights areas for watershed restoration to benefit aquatic habitat (e.g., road rehab work in Lower Mad FPU) and areas in which potential downstream impacts of management actions need to be weighed against high priority resource values (e.g., indirect effects of actions in Brennegan-Preston FPU). Adequate integration of all resource needs in multi-year project planning will require this level of information.

Implementation of Follow-up Actions to this Assessment

The most significant "follow-up actions" to be taken in response to this watershed assessment are those site-specific actions that can be implemented now that will have the most dramatic effect in maintaining or restoring the ecosystem components listed in the Management Strategy priority table (Table 5.1). High priority is given to restoration of vegetative structure and condition in those types most influenced by human activities, especially within riparian areas.

However, in many cases, more detailed inventory, analysis and planning will be needed to help bring tighter focus to the prioritization of site-specific actions. In addition, this assessment has identified several information gaps that need to be filled for the purpose of up-dating the findings in this document. These types of "Follow-up Actions," listed in Chapter 4, are targeted at filling information gaps and/or providing more site-specific analysis for project level work. During synthesis, it became clear that these "follow-up" priorities surfaced as management strategies. Table 5.2 summarizes high priority follow-up work based on this observation.

Implementation of Proposed Monitoring

As noted above, monitoring coordination in the analysis area is a major follow-up need. A coordinated plan would eliminate duplication of effort, increase quality control and improve information sharing. The plan should provide a balance between both long-term baseline monitoring (e.g., mainstem Entiat sediment core sampling) and more short-term project-level monitoring (e.g., evaluation of detrimental soil disturbance within an activity area).

The "Monitoring & Evaluation" tasks listed in Chapter 4 include both inventory and monitoring items, targeted at providing more site-specific information to support future work. The findings from this version of the watershed analysis suggest the following inventory and monitoring items are priorities for implementation (Table 5.3). This table is not intended to be an exhaustive list of inventory/monitoring needs. The coordinated monitoring plan will provide a more complete coverage of priority monitoring tasks. Emphasis will be placed on priority monitoring on a representative basis, with intensity varying based on issue sensitivity.

Table 5.2
Priority Follow-up Actions - Entiat Analysis Area *

Follow-Up Action	Text Reference
Promote a coordinated resource management approach in the analysis area, involving all stakeholders. Approach to include coordinated inventory and planning, as well as implementation and monitoring.	MS 10-12 - CRMP Planning process; Chapter 4, SWF follow-up action #2
Complete and implement an Access and Travel Management Plan for the analysis area.	MS 7 & 16
Complete province level wildlife analyses, habitat surveys and species management plans on a priority basis (critical, key & unique habitats). Complete a Dead and Defective Tree Management Plan. High priority to develop comprehensive bighorn sheep management plan in conjunction with WDFW & USFWS.	Chapter 4, Wildlife follow-up actions; MS 6, 25, 32, 35, 45
Develop and implement an overall strategy for commercial grazing allotments that will address long-term vegetation management and range improvement rehabilitation. Lower priority to complete LAC analysis and historic grazing impact assessment in open sub-alpine areas.	MS 44, 45, 64
Develop a Comprehensive Recreation Use Strategy Plan, including vegetation management, a site rehabilitation/ maintenance program and an Accessibility Survey & Analysis, in concert with access and travel management planning.	MS 7, 16, 22, 24
Update the Entiat Valley Visual Corridor Plan (1978) in concert with the Comprehensive Recreation Use Strategy Plan.	MS 14
Develop and implement an integrated noxious weed management plan, with emphasis on prevention of further spread.	MS 8

* The order of listing in Table 5.2 is not intended to reflect priority among the tasks identified. "MS" = Management Strategy.

Table 5.3
Inventory & Monitoring Priorities - Entiat Analysis Area *

Inventory/Monitoring	Text Reference
Existing condition and trends in vegetative structure & condition - Broad stand exam/vegetation condition surveys in unburned and partially burned areas; Vegetative recovery in riparian areas; Analysis and monitoring of forage/cover availability	Veg Monitoring, Ch 4; MS 45
BAER seeding and native plant recovery response	MS 9; SWF Monitoring, Ch 4
Plant species of concern - noxious weeds, sensitive plants	MS 6 & 8
Tyee Fire recovery projects for scenic integrity	MS 13, 34, 38-41
Post-fire recovery of Range Allotments (Recovery criteria)	MS 44; Appendix G-4
Forage utilization levels in active commercial grazing allotments (livestock and wildife)	MS 44
Road management activities (e.g., use impacts, maintenance needs, closure effectiveness)	MS 7
Soil quality - Results of new ground-disturbing activity & recovery of sites with residual impacts (detrimental soil disturbance)	MS 3, 4
Impacts from recreation use, on facilities & resources, especially in developed sites & dispersed sites outside of wilderness	MS 16-22 & 24
Inventory unique/critical/key wildlife habitats (e.g., winter range); Monitor effect of management on these habitats & species use.	MS 6 & 32; WL Monitoring, Ch 4
Inventory & monitor T&E species (grizzly, bald eagle, peregrines, wolves, spotted owl), MIS species and Survey and Manage species and Sensitive Species (e.g., Swakane Bighorn sheep population), as per WNF & NW Forest Plan direction	WL Monitoring, Ch 4; MS 6, 25 & 32
Monitor snag and down woody debris trends	MS 15; WL Monitoring, Ch 4
Aquatic habitat conditions - fine sediment deposition, water temperature, stream surveys, fish resource information	SWF Monitoring, Ch 4
Water quantity and quality - select parameters to evaluate post-fire conditions and compliance with state standards	SWF Monitoring, Ch 4
Effectiveness of watershed restoration projects	SWF Monitoring, Ch 4

* The order of listing in Table 5.3 is not intended to reflect priority among the tasks identified. "MS" = Management Strategy.

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APPENDICES

for

WATERSHED ASSESSMENT

Entiat Analysis Area

Version 2.0

April 1996

Prepared by

Entiat Watershed Analysis Teams

Appendix A
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Wildlife

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Appendix A-1

Entiat Analysis Area
Communities, Habitats and Species Background Information

Overview

Refer to the analysis summary for Wildlife in Chapter 2.

Wildlife Groupings

For this watershed analysis, a number of methods were used to group animal species in order to simplify management of the 423 wildlife species on the Forest (distilled to 50 to 60 species or habitats). Some overlap occurs between these groupings. Non-vertebrates have not been included in these lists. Tables of habitat estimates can be found in Chapter 2 (Tables 2.1-2.5).

Following are the definitions and supplemental text for these tables:

Habitat or Species Definitions

Plant Communities (Table 2.1)

Shrub/Steppe - Dry habitat of shrubs and grasses. Has low potential to grow trees (i.e., full density of trees my provide up to 40 percent crown closure.

Low Elevation - Pine/oak, Douglas-fir, low site grand fir and ponderosa pine series.

Mixed Conifer - High site grand fir, western hemlock, and silver fir series.

High Elevation - Subalpine, white bark pine, lodgepole and mountain hemlock series.

Riparian - Riparian habitat.

Successional Stages (Table 2.1)

Early Seral - Tree stands with dominants averaging 1-9" DBH.

Mid Seral - Tree stands with dominants averaging 9-16" DBH.

Late Seral - Tree stands with dominants averaging 16"+ DBH.

Special, Unique and Created Habitats (Table 2.2)

Wetlands - Permanent wet area dominated by emergent vegetation.

Springs/Guzzlers/Seeps/Wallows - Sources of water in spots.

Water Surface - Lakes, streams, ponds, rivers, bogs, swamps, etc.

Caves/Tunnels

Meadows

Rocky Terrain - Cliffs, talus slopes, etc.

Beaches/Mud Flats/Gravel Bars - Areas nearly bare of vegetation near water.

Non-Riparian Deciduous - Deciduous tree habitat not in riparian areas.

Other Structures - Colonies, raptor nests.

Man-made Structures - Buildings, bridges, towers, etc.

Columbia River Breaks - The varied terrain and rocky sites, in close proximity to the Columbia River, add to the potential for unique habitats to be found within these areas. In fact, at least two new species of land snails have been found on these lands. Bald eagles, peregrine falcon, ferruginous hawks, sharp-tailed grouse, mountain quail, upland sandpipers, specific species of bats, reptiles, and certain plants which are known or suspected to be found in other areas within the Entiat Watershed Analysis Area, are more apt to be found on these Columbia River Breaks. There is little current knowledge of these areas on which to draw for analysis of effects of potential management activities.

Critical Habitat (Table 2.3)

Critical habitats are those that have been determined by the Department of Interior to be important for survival of a specific threatened or endangered species, and for which that determination and delineation of the area has been published in the Federal Register.

Within the Entiat Watershed Analysis Area Critical Habitat for the northern spotted owl has been designated in the Indian Creek and Mad River Drainages.

Threatened or Endangered Species (Table 2.3)

Habitats for the following threatened and endangered species are considered in biological evaluations for potential impacts of proposed actions on those species. While some of the habitats described below may be within the critical habitat of the northern spotted owl, those outside of that area or for other species are not officially designated critical habitats.

Northern Spotted Owl

Habitat and Species Existence - Spotted owls have been known to exist in this watershed since 1986, when the first inventories were completed. Prior to the Tyee Fire, six pairs were known to exist. After the Tyee Fire, six pairs and two singles are known to exist and several "historic sightings were recorded. There were 19,145 acres of suitable habitat before the fires and 9,500 acres of suitable habitat existing after the 1994 fires.

Habitat Definitions - Grand fir, western hemlock, silver fir and high site indexes of Douglas-fir series comprise spotted owl habitat. Often, late seral stages provide habitat and sometimes mid-seral stages, as well. Generally, habitat has crown closure of 70 percent or greater, dominant trees larger than 12" dbh, mistletoe presence, large numbers of standing dead trees, large amounts of down trees, and a muli-layered and multi-aged stand. Preferred prey are flying squirrels and bushy-tailed woodrats.

Habitat Concerns - Fires of 1994 destroyed or damaged spotted owl habitat. Lack of fire allowed spotted owl habitat to develop. While logging has eliminated habitat, it may have also reduced the fire potential around nest sites.

Recommendations - Follow direction in the Northwest Forest Plan and Draft Northern Spotted Owl Recovery Plan (USDI, 1990).

Condition Trends --Habitat and populations are decreasing over the next 40-60 years; they may stabilize after that.

Bald Eagle

Habitat and Species Existence - Eagles are known to feed in this watershed during the winter. No nest sites have been found. Potential nest sites have been identified. There are undetermined acres of suitable nesting habitat and approximately 100,000 acres of feeding habitat. Potential territiories were identified in the draft Wenatchee Eagle Plan. It is unknown if there are actively-used roost sites in the watershed.

Habitat Definitions - Shrub-steppe, meadows, Douglas-fir series, marshes, rivers, riparian, streams, and lakes are used by eagles for feeding. Douglas-fir, ponderosa pine, grand fir, western hemlock, and silver fir series are used for nesting. Needs large trees for nesting and stands of large trees for roosting. Preferred food is fish and ducks, but will use winter-killed deer as a winter food source.

Habitat Concerns - Logging of suitable nesting/roosting habitat and recreation disturbances in nesting/ feeding habitat. Loss of prey base.

Recommendations - See Bald Eagle Recovery Plan, Forest Plan, and Draft Forest Bald Eagle Plan.

Condition Trends - Stable or increasing populations.

Peregrine Falcon

Habitat and Species Existence - Birds have been seen in this watershed. There are no known nest sites. There are (unknown) acres of potential nesting habitat and approximately 100,000 acres of feeding habitat.

Habitat Definitions - Nest sites are large rocky cliffs. Feeding habitat is near marshes, lakes, rivers, open upland habitat. Feeds primarily on birds.

Habitat Concerns - Falconry, feeding areas, disturbance, and prey base.

Recommendations - See Peregrine Falcon Recovery Plan, Forest Plan for recommendations.

Condition Trends - Stable or increasing populations. Habitat stable.

Gray Wolf

Habitat and Species Existence - Wolves have been sighted in this watershed for many years. No den sites are known. There are 235,000 acres of suitable habitat. Many of the suitable acres (about 50,000) are not available for wolf use due to human activites.

Habitat Definitions--Denning habitat is located in remote country with sources of ungulates and water nearby. Prey includes deer, elk, mountain goats, bighorn sheep and other small mammals.

Habitat Concerns - Human-induced mortality (shooting, poisoning, trapping), human disturbances, habitat alterations, reduced deer and elk populations, and grazing of domestic livestock. The average road density in this watershed is higher than the one mile per section recommended for this species.

Recommendations - See Forest Plan and draft guidelines for wolves.

Condition Trends - Wolves are rare in Washington and the Entiat Watershed Assessment area is not being fully utilized to its potential for this species. However, mule deer, which are the primary prey for wolves in this area, are expected to be at a lower-than-potential population for the next several years. This is due to winter habitat degradation by the Tyee Fire of 1994. Therefore, population potential for wolves would also be lower-than-normal during the period of fire recovery.

Grizzly Bear

Habitat and Species Existence - There have been grizzly bear sightings in this watershed, but no confirmed sightings. There are 235,000 acres of suitable habitat in the watershed. Many of the suitable acres (about 100,000) are not available for bear use due to human activities.

Habitat Definitions - Denning occurs at higher elevations in the alpine, subalpine fir and white bark pine series. Forages primarily on vegetation in wet/dry meadows, marshes, low gradient stream bottoms, riparian areas, berry-producing shrub fields, avalanche chutes, rivers, and streams. Feeds on winter-killed deer, ground squirrels, mice, grubs, and ants, as well.

Habitat Concerns - Loss of secluded habitat, human-induced mortality and disturbance, and habitat alterations (logging, mining, road construction, trails, grazing). The average road density in this watershed is higher than the one mile per section recommended for grizzly bear.

Recommendations - See draft Recovery Plan and Forest Plan.

Condition Trends - Human use of suitable habitat is increasing, so habitat capability is likely decreasing. Population trend is unknown.

Sensitive Species (Table 2.4)

California Wolverine

Habitat and Species Existence - Sightings and habitat for this species have been documented in this watershed. This species once occurred throughout the western forests. Their populations are considered to be low in number throughout the range of this species. The USFWS is reviewing this species to determine if listing as threatened or endangered is warranted.

There are potentially 134,000 acres of forested land that could be used by wolverines in this watershed. There are 25,000 acres of talus slopes for denning or feeding habitat.

Habitat Definitions - This species is very reclusive. It often uses talus slopes, high elevation forests and meadow areas in spring, summer and fall. Because it feeds primarily on deer and elk carrion, it also uses lower elevation forests during the winter. Wolverine are easy to trap and impacted by people living in the forest.

Habitat Concerns - The average road density is higher than the one mile per section recommended in most of the watershed. Many residents live along the Entiat River, thus reducing habitat effectiveness for this species. The suitable habitat in this watershed was reduced by about 48,000 acres during 1994 fires. High

populations of mule deer provide a good source of food for wolverine, but deer populations are expected to decrease for the next 10-30 years due to human activities and ecosystem management decreasing habitat.

Recommendations

a. Province plans and habitat distribution models should be completed to analyze habitat effectiveness, connectivity, and availability of habitat. Utilize the recently-prepared conservation plan for this species to develop province plans.
b. A monitoring plan for this species should be prepared. Inventory habitat for this species before project implementation begins.
c. Reduce road densities.
d. Manage habitat away from local residences.
e. Provide cover for prey species, including dead/down logs and shrubs that create cover and food.
f. Provide large amounts of dead/down logs for denning.
g. Provide connectivity of cover.
h. Plant trees to regenerate forested stands of cover.
i. Maintain high populations of deer to provide carrion.
j. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

North American Lynx

Habitat and Species Existence - Occurrence of lynx in the watershed is documented. Lynx populations are low throughout its range in Washington. It is on the Regional Forester's Sensitive Species List and is listed as Threatened by the State of Washington. Its status as a Federal candidate species was changed (Federal Register 61 (40):7596-7613) to a "species of concern" for the USFWS.

Lynx use a mosaic of seral stand conditions with early successional lodgepole pine thickets for hunting and late successional stands of larger conifers for denning, which are the most important. Travel routes between habitat units are also essential.

Habitat Definitions - Lynx are associated with habitat above 4000 feet elevation (silver fir, sub-alpine fir, white bark pine series). Snowshoe hare are the primary prey species for lynx. This species requires a mosaic of forest habitat conditions; they especially need young thickets for hunting prey and old growth/mature forests for denning. They tend to locate their dens in piles of large down wood on moderate slopes with a north/ northeast aspect.

Habitat Concerns - The fires of 1994 helped create a mosaic of high elevation forest. Road densities may affect lynx populations. Our knowledge of local populations and numbers is minimal. The lack of quality denning habitat and insufficient prey populations can limit lynx reproduction. Connectivity of habitat within and between home ranges improves survival of this species. Lynx habitat is relatively fire resistant due to elevation and rainfall.

Recommendations

a. Establish a monitoring plan to determine and track population trends. Inventory species prior to project implementation.
b. Prepare province plans and habitat distribution modules to analyze habitat effectiveness, connectivity, and availability of habitat. Use the recently prepared conservation plans and survey methods prepared for this species (WDFW PHS Lynx Habitat Management and Recommendations).
c. Reduce open road density; the objective for open road densities in primary habitat is 1 mile/mi^2 and 2 mi/mi^2 in secondary lynx habitat.

d. Provide habitat for high populations of snowshoe hare.
e. To provide habitat for lynx, a watershed should retain about 10 percent of the area in old growth/mature forest for denning, at least 30 percent of the area in early seral stage vegetation (dense thickets of willow/and lodgepole pine), 30 percent in either prey/travel conditions, and the remaining area in non-suitable condition.
f. Provide sufficient cover for prey species. Dead and down logs and shrubs improve cover quality and provide food.
g. Retain large amounts of dead, down logs for denning.
h. Provide connectivity of cover within and between lynx home ranges.
i. Stand size of prey habitat should be larger than 20 acres; 100 acres is preferred.
j. Review the cumulative effects of other resource activities on this species.
k. Lynx recommendations - to achieve the desired forest landscape mosaic for lynx, timber harvest management units should be 20 to 40 acres in size. Where possible, these harvest units should be designed to provide maximum edge with periodic constrictions, while avoiding openings greater than 300 feet in width. In management units that are 40 acres or less and completely bordered by suitable lynx denning habitat, forage and/or travel cover, created openings can exceed 300 feet in width as long as they are not located on saddles, ridges, or riparian areas. Where proposed timber harvest management units are greater than 40 acres, consult with WDFW to ensure that harvest unit designs will not conflict with meeting lynx habitat needs over time and space.

Condition Trend - Populations and habitat are thought to be decreasing.

Pacific Fisher

Habitat and Species Existence--There are no sightings for this species within this watershed but there are undetermined acres of suitable habitat. This species is known to exist on the Forest and the best remaining populations in Washington appear to be in Eastern Washington.

Habitat Definitions - The fisher is generally associated with late seral, mixed conifer forests at low to moderate elevations. Preferred habitat has a 70 percent or greater forest canopy, multi-storied stands, large snags and down trees. It is often within 1000 feet of riparian habitat, bogs, wetlands or alder glades. This species preys mostly on small mammals, with snowshoe hares and tree squirrels at the top of the list. Fisher are excellent tree climbers and can move on the snow fairly well.

Fisher have a low reproductive rate and this limits their ability to recover from population reductions (due to trapping, shooting, and death from domestic animals).

Habitat Concerns - The fires of 1994 significantly reduced the potential to provide suitable habitat for fisher in the next 100 years. Squirrels and snowshoe hares often use downed logs and snags as cover. Retaining large trees in the burn area would enhance habitat as new stands of trees regenerate. Many of the roads in the watershed are within 1000 feet of riparian habitat that is preferred habitat for fisher. Local residents own domestic animals that may kill fisher. Our knowlege of local populations and abundance is almost non-existent.

Recommendations
a. Establish a monitoring plan to locate and follow population trends. Inventory for species prior to project implementation.
b. Prepare province plans and habitat distribution models to analyze habitat effectiveness, connectivity, and availablity of habitat. Use the recently-prepared conservation plan and survey methods for this species.
c. Provide dead/down material for squirrels that will in turn provide prey for large predators, such as fisher.

d. Leave standing tree habitat for primary cavity excavators in order to provide habitat for prey species.
e. Do not plan to manage habitat for fisher near residential areas.
f. Limit road building in or near riparian habitat; relocate/close roads in the riparian zone.
g. Minimize road building in saddles.
h. Manage new stands to become mature or old growth stands.
i. Increase ponderosa pine habitat and porcupine populations.
j. Plant trees in burned areas to accelerate the recovery of habitat.
k. Protect stands from catastrophic fire, as much as possible.
l. Reduce predation by domestic animals by using education of the public.
m. Review the cumulative effects of other resource activities on this species.

Condition Trend--Unknown.

Townsend's Big-Eared Bat

Habitat and Species Existence - Big-eared bat populations are not known to occur within this watershed. There are undetermined acres of potential feeding habitat and undetermined acres of roosting, nursery or hibernaculum habitat available in this watershed. Only one population is known to occur on the Forest and another site that may be inhabited has been located. Additional information and surveys are needed to determine if populations occur within this watershed.

Habitat Definitions - Roosting, nursery or hibernaculum sites are usually in caves, mines, talus slopes, under bridges, or in old buildings. Temperature appears to be the critical factor at roosting, nursery and hibernaculum sites. This species feeds primarily on insects, especially moths.

Habitat Concerns - Destruction of roosting sites. Bats are sensitive to human activity and may move away to other sites. Human activity may impact populations during hibernation. Pesticides reduce the bat's prey base.

Recommendations
a. Inventory potential roost, nursery and hibernaculum sites to determine occupancy before taking actions that could reduce populations.
b. Retain cover to maintain temperatures around entrances to roosting, nursery and hibernaculum sites.
c. Manage human activities to prevent reductions in populations.
d. Maintain adequate moth populations for food.
e. Design bridges and buildings to accommodate bats.
f. Where tree dens are limited, provide bat roost boxes.
g. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

Spotted Bat

Habitat and Species Existence--This species is not known to exist in this watershed. It has been located to the north, east and south of this watershed and the likelihood is high of its use of this area. Although habitat for spotted bats likely exist in the analysis area, the amount has not been determined.

Habitat Definitions - Feeding habitat is shrub-steppe and roosting habitat is cliffs.

Habitat Concerns - Concerns for this species will be determined when and if it is found to occur in this watershed.

Recommendations
a. Inventory to locate populations. Inventory for species prior to project implementation.
b. Study the known locations to determine why these populations are low.
c. Review the cumulative effects of other resource activities on this species.

Condition Trend--Unknown.

Bighorn Sheep

Habitat and Species Existence - This species is found in the adjacent watershed and may use some habitat within this watershed. There have been inventories over the years which determined that the bighorn sheep population is decreasing. A cooperative radio telemetry study (USFS and Washington Department of Fish and Wildlife) is in progress to determine the cause of this decline. Habitat for this species has been mapped and some resource improvement projects have been implemented. There are less than undetermined acres of habitat in this watershed.

Habitat Definitions - Bighorn sheep live in moderately steep, open, dry grass/shrub habitats, generally below 4000 feet in elevation (shrub-steppe series). Their winter range is composed of south-facing open slopes with nearby forests for cover. Sheep habitat overlaps deer winter range. Sheep populations were more abundant on the Forest before white people settled the area. Populations were eliminated from the Forest between 1900 and 1940, but re-introductions occurred in the 1960's and 70's.

Habitat Concerns - The current population is too small to maintain population viability. Domestic sheep carry a disease that is fatal to bighorn sheep, it is not known if the domestic sheep that occupy the nearby allotment are carriers of this disease but it is highly likely they do. Poaching, human disturbance, and road access may be reducing habitat capability in the area. Fire has improved the habitat for this species in the last 10 years.

Recommendations
a. Continue studies and population monitoring in progress.
b. Decide if the bighorn population will be managed to maintain viability or allowed to go extinct, locally.
c. Gain information on the role of fire in maintaining sheep habitat.
d. Resolve domestic sheep grazing and bighorn sheep management conflicts. Domestic sheep should not be in the same area as bighorn.
e. Review the cumulative effects of other resource activities on this species.

Condition Trend - The future of the population of bighorn sheep in this watershed, as presently managed, is bound for extinction in the next 10 - 20 years.

Northwestern Pond Turtle

Habitat and Species Existence - This species may exist in this watershed. However, there are no records of this species occuring in this area. There are undetermined acres of suitable habitat available.

Habitat Definitions - Ponds and small lakes with abundant vegetation. Marshes, slow-moving streams, and reservoirs. Usually at low elevations where it is warm. It forms an earthen chamber in a sunny spot near water's edge or some distance away in a field to lay eggs.

Habitat Concerns - Adequate information on local populations is not available. Livestock watering and grazing around low elevation ponds, lakes and slow moving streams likely affect this species. Road building in the vicinity of habitat may cause problems. Human access to habitat may result in indiscriminate shooting. Adjacent landowners and residents likely eliminate or modify habitat. High-intensity fires may have damaged

some habitat. Check dams and ponds built after the fire may provide additional habitat for this species and other amphibians.

Recommendations

a. Establish a monitoring plan to locate and track population trends. Inventory for species prior to project implementation.
b. Prepare province plans to analyze habitat effectiveness, connectivity and availability of habitat.
c. Complete studies to answer, identify, and resolve problems with viability.
d. Manage livestock grazing in low elevation areas differently to maintain habitat.
e. Encourage local landowners to plan for habitat maintenance.
f. Do not build roads near/to ponds, marshes, or streams. Close/obliterate roads to ponds, marshes and slow-moving streams.
g. Manage fire to reduce the potential for high-intensity fires.
f. Review the cumulative effects of other resource activities on this species.

Condition Trend--Unknown.

Spotted Frog

Habitat and Species Existence - May exist in the upper reaches of the Entiat watershed. There are undetermined acres of suitable habitat in this watershed. No inventories or records were found. There are sightings of spotted frogs on the Forest.

Habitat Definitions --It breeds from March to June in mountainous areas near cold streams and lakes. Moves overland in spring and summer and is diurnal. It does not regularly frequent ponds and lakes where water is warm enough to allow for extensive growth of emergent vegetation such as cattails.

Habitat Concerns - Adequate information on population locations is not available. Planting fish in high elevation lakes appears to increase predation on this frog and lower populations. Livestock watering and grazing around streams and lakes may have effected this species.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b. Prepare province plans to analyze habitat effectiveness, connectivity and availability of habitat.
c. Complete studies to answer, identify, and resolve problems with viability.
d. Eliminate conflicts between livestock grazing and frog habitat.
e. Eliminate conflicts with fish planting in high elevation lakes inhabited by frogs.
f. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown

Northern Red-Legged Frog

Habitat and Species Existence - Species has been verified on other parts of the Forest, but not in this watershed. Habitat is present and the species may exist here. There are undetermined acres of suitable reproductive habitat.

Habitat Definitions - Egg masses are laid January to March (probably later here) in permanent bodies of water; usually ponds or other water with extensive vegetation. It also likes damp woods. Found from sea level to 8000 feet elevation.

Habitat Concerns - Adequate information on population locations is not available. Population seems to be small on the Forest as most inventories have not resulted in a finding of this species. Inventories may not be concentrating on the right habitat for this species. Timber harvesting may have removed the damp riparian forests used as reproductive sites. Livestock watering in ponds within forests may have reduced the population potential of ponds.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species prior to project implementation.
b. Prepare province plans to analyze habitat effectiveness, connectivity and availability of habitat.
c. Complete studies to answer, identify, and resolve viability problems.
d. Eliminate conflicts between livestock grazing and frog habitat.
e. Maintain damp forest conditions around ponds.
f. Create ponds by introducing beaver or by creating dams.
g. Review the cumulative effects of other resource activities on this species.

Condition Trend - Uncertain.

Cascades Frog

Habitat and Species Existence - This species occurs on the Forest but no sightings have been made in this watershed. Undetermined acres of suitable habitat occur in this watershed.

Habitat Definitions - Breeds from May to August in streams, ponds, and lakes above 3000 feet in elevation. Also found in mountain meadows; uses water and vegetation around these areas and is diurnal. Frequently seen preying on insects or basking on rocks in or near water. It will swim when threatened instead of diving or hiding.

Habitat Concerns - Adequate information on population locations is not available. Livestock feeding and watering in meadows, along streams, ponds and lakes may have reduced habitat for this species. Timber harvesting and roading may affect habitat for this species. Campgrounds, special use permits, and camping in suitable habitat may affect populations and damage habitat.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b. Prepare province plans to analyze habitat effectiveness, connectivity and availability of habitat.
c. Conduct studies to answer, identify, and resolve viability problems.
d. Eliminate conflicts between livestock grazing and frog habitat.
e. Reduce the effect of roads on habitat.
f. Review the cumulative effects of other resource activities on this species.

Condition Trend - Uncertain.

Larch Mountain Salamander

Habitat and Species Existence - No sightings were made of this species within this watershed, but it was found on the Forest in 1994. Potentially suitable habitat needs to be identified and surveyed.

Habitat Definitions - Breeding habits are unknown. It prefers to inhabit lava talus slopes and rocky outcrops in western hemlock series. Uses rocks at the base of outcrops or under the forest litter away from seeps and streams. Eats mites and springtails.

Habitat Concerns - More information is needed on this species and its range. Timber harvests and roads may damage habitat.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b. Prepare province plans to analyze habitat effectiveness, connectivity, and availability of habitat.
c. Complete studies to answer, identify, and resolve problems with viability.
d. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

Harlequin Duck

Habitat and Species Existence - There have been sightings along the Entiat River; the Entiat and Mad Rivers both provide suitable habitat. There are undetermined miles of suitable stream habitat in this watershed. This species is found in pristine, rapid-flowing rivers and is believed to be low in numbers on the Forest.

Habitat Definitions - Feeds in rapidly-flowing streams and rivers on aquatic insects, mollusks, and crustaceans. Nests in riparian habitat along the streambank. Found on the Forest in spring, summer, and fall; and in winter along the ocean coast.

Habitat Concerns - Maintain riparian cover and vegetation along streams and rivers. Human activity and disturbance in nesting areas can limit reproduction.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory activity areas for this species before projects commence.
b. Prepare province plans to identify the availability of habitat and Forest-wide condition of population.
c. Trails should be located more than 200 feet from streams.
d. Discourage recreational use in nesting areas during nesting season.
e. Explore methods to increase habitat effectiveness and availability.
f. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

White-headed Woodpecker

Habitat and Species Existence - Sightings for this species have been recorded in this watershed. Populations are considered low in Washington. It is not known how this watershed fits into viability for this species. There is thought to be undetermined acres of suitable habitat.

Habitat Definitions - Primary habitat is the ponderosa pine series, but white-headed woodpeckers also feed and nest in lodgepole pine and grand fir series. They feed on insects and frequently drink water. Nest cavities are found in standing, dead trees 4-25 feet above ground and are 8-15 inches deep. Pair territories may be as small as five acres.

Habitat Concerns - About 40,000 acres of potentially suitable habitat burned in the 1994 Tyee Fire. Snag retention may provide for populations over the next 10-30 years. If larger snags are left now, the population may persist longer through time. Nonetheless, it is likely that populations will be very low in the burned area for 30-100 years until new forest stands are established.

To help mitigate for the large acreage that burned and thereby eliminated habitat, stands with green trees remaining around the intensively-burned area should retain large numbers of snags 30-100 years hence. This may require leaving more green trees than normal and creating snags from green trees.

Recommendations
a. Leave 60 snags over 15 inches dbh per 100 acres for 100 percent population potential.
b. Establish a monitoring plan to follow population trends.
c. Retain snags near water.
d. Establish additional water sites or spring developments.
e. Reforest the burned areas.
f. Protect stands from catastrophic fire.
g. Leave large snags to provide nesting habitat until new trees are large enough for nesting.
h. Consider snag creation when new trees reach 15" dbh.
i. Prepare a province plan so watersheds can be assessed for habitat connectivity and species viability.
j. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

Northern Goshawk

Habitat and Species Existence - There were several nest sites in this watershed. The fire burned a number of nest sites. There are 74,000 acres of suitable habitat in this watershed.

Habitat Definitions - Goshawks use most series that contain conifer trees. The elevation range is below 1000 feet to about 7000 feet. Nests are usually in live trees in a defective portion or mistletoe broom. Tree stands usually have high crown closures. Preferred prey species is small birds, but they will eat small mammals.

Habitat Concerns - Wildfires eliminated a lot of goshawk habitat in this watershed in 1994. Falconers capture the young and use them for falconry. Timber harvest reduces the effectiveness of habitat. Road access noise and activities can disturb nesting/reproduction.

Recommendations
a. Inventory nests prior to project implementation.
b. Protect nest sites with sufficient habitat to maintain effective reproduction.
c. Maintain sufficient habitat around nests to ensure reproductive success.
d. Maintain connectivity of cover between habitat units to reduce the risk of predation on goshawks.
e. Prepare province plans and habitat distribution modules to analyze the connectivity of habitat within territories and between watersheds.
f. Follow guidelines in conservation plans developed for the northern goshawk.
g. Provide large down logs in the burned area as prey habitat and plucking posts.
h. Plant trees on capable growing sites so they can become habitat.
i. Protect habitat from wildfire.
j. Restrict activites (March through July) within ½ mile of nest if they may affect nesting success.
k. Review the cumulative effects of other resource activities on this species.

Condition Trend - Habitat and populations were high prior to the 1994 fires. Populations will likely continue to decline for another 50-100 years, then regeneration and new stands will begin to provide new habitat.

Flammulated Owl

Habitat and Species Existence - Sightings were made in this watershed and there were several sightings on the Forest. There are 10,000 acres of suitable habitat. Both the 1988 and 1994 fires burned acreages of suitable habitat.

Habitat Definitions - This owl eats mostly insects and is migratory. They are present in this area only in spring, summer and fall. Large moths are a favorite prey for this owl (note there are four times as many Lepodoptern species associated with pine/oak and ponderosa pine series). Preferred feeding sites are in low shrub cover. Habitat is in open coniferous forest (pine/oak, ponderosa pine and Douglas-fir Series). This species needs cavities created by woodpeckers for nesting. Mature and old growth successional stages are preferred (stands older than 80 years).

Habitat Concerns - Fires and fire suppression affect the habitat of this species. Domestic livestock grazing may affect the availability of prey for this owl. Cavity availability is limited. Clearcut logging eliminates habitat. Partial cutting that leaves necessary components has little effect. Dense thickets of pine and fir are not good habitat for this owl. Recreational activities that do not damage trees do not appear to cause problems for this species.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b Prepare province plans and habitat distribution models to analyze habitat effectiveness, connectivity or availablity of habitat. Use the recently-prepared conservation plan as a source of information and guidelines.
c. Manage livestock grazing to maintain or increase the owl's food supply.
d. Manage fire to maintain ecosystem components.
e. Manage timber harvest in an uneven-aged management strategy.
f. Maintain large dead trees for pileated and flicker excavation and nesting--these often become nests for flammulated owls.
g. Plant trees to re-establish mature and old growth forest conditions in the future.
h. Maintain large snags with existing cavities.
i. Review the cumulative effects of other resource activities on this species.

Condition Trend - The post-fire trend is likely the increased availability of habitat in 50-100 years.

Columbian Sharp-tailed Grouse

Habitat and Species Existence - This species of grouse is not known to occur on the Forest at this time, but formerly existed in the shrub-steppe habitat. There are less than 66,000 acres of suitable habitat in the watershed.

Habitat Definitions - Habitat is native bunchgrass and shrub-steppe series. Important vegetation is bunch-grass, tall forbs, sagebrush, snowberry, service berry, hawthorn, and birch. Winter foods are mainly buds, twigs and catkins from large shrubs and trees. Leks are usually on a knoll or flat spot with sparse vegetation. Populations usually range out two to three miles from leks.

Habitat Concerns - This species of grouse could be introduced back to the Forest with some habitat management. The State of Washington has a management plan for this species and would like to establish an agreement to reintroduce this species throughout its former range. Domestic livestock grazing and agricultural developments have reduced habitat. Hunting and road access have helped eliminate this species from many portions of its former range.

Recommendations

a. Incorporate plant species desired by grouse into the recovery of the mule deer winter range.
b. Cooperate with the State to reintroduce this species.
c. Manage livestock grazing to maintain grouse habitat.
d. Establish water developments to provide water.
e. Reduce road access to enhance habitat for this species.
f. Encourage shrub and deciduous tree to growth in riparian areas to provide wintering habitat.

Condition Trend--It may be that this species could be reintroduced to Chelan County and populations would increase.

Western Sage Grouse

Habitat and Species Existence - This species of grouse is not known to exist on the Forest at this time, but did exist in the shrub-steppe habitat on the Forest in the past. There are less than 66,000 acres of suitable habitat.

Habitat Definitions - Primary habitat is shrub-steppe series. Feeds in early morning around ponds, springs, and seeps on leaves of forbs, pods, buds and on insects. Roosts on ground at night. Breeding takes place at leks.

Habitat Concerns - This species of grouse could be introduced back to the Forest with some habitat management. Cattle grazing, agricultural development, riparian habitat alterations, and hunting have decreased habitat and populations of this species.

Recommendations-Work with Washington Department of Fish and Wildlife in planning any proposed management or reintroduction of sage grouse. Potential habitat management could include:

a. Incorporate plant species desired for grouse into the recovery of the mule deer winter range.
b. Cooperate with the State to reintroduce this species.
c. Manage livestock grazing to maintain/improve grouse habitat.
d. Establish water developments to provide water and green vegetation.
e. Reduce road access to enhance habitat by decreasing human predation.
f. Encourage growth of shrub and deciduous tree habitat in riparian areas to provide for wintering habitat.
g. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown. Populations could increase.

Mountain Quail

Habitat and Species Existence - This species is known to exist on the Forest but no sightings are available for this watershed. There are 19,000 acres of suitable habitat available.

Habitat Definitions - Prefers the edge of coniferous forests. Likes areas of dense brush that often result from unburned clearcuts. Lives from 1500 feet elevation to 10,000 feet. Migrates into the mountains in spring and downward in fall.

Habitat Concerns - There is a lack of information regarding habitat needs, distribution, and connectivity needed by this species. It is not known if populations of this species are viable in this province.

Recommendations
a. Inventory for populations.
b. Gather information on habitat needs of this species.
c. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

Loggerhead Shrike

Habitat and Species Existence - No records of sightings exist, but it is likely there are populations within this watershed. There are no acres of suitable habitat.

Habitat Definitions - Prefers dense, open country of willow brush bordered by swamps and bogs. Preys on other birds, small mammals and insects. Builds nest in spruce trees, willows, or bushes.

Habitat Concerns - Little is known about this species, its populations, or habitats in this area.

Recommendations
a. Establish a monitoring plan to locate and follow population trends. Inventory activity areas for this species before projects commence.
b. Prepare province plans to identify available habitat and Forest-wide population conditions.
c. Studies are needed to understand how this species uses habitats on this Forest.

Condition Trend - Unknown.

Black Tern

Habitat and Species Existence - This watershed is within the breeding range of this species, but no sightings have been recorded. It is not known if there is sufficient habitat or if populations occur within this watershed.

There are estimated to be 1,315 acres of marshes, meadows, rivers in this watershed that could provide habitat for this species.

Habitat Definitions - Feeding habitat includes marshes, meadows, lakes and rivers; it nests in marshes on floating vegetion.

Recommendations
a. Inventory for populations.
b. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

Upland Sandpiper

Habitat and Species Existence - There are no records of this species occuring in this watershed. Habitat for it has not been inventoried.

Habitat Definitions - Lives in hayfields, meadows or hilly pastures. Feeds on grasshoppers, crickets and weevils. Nests in a grass-lined depression on the ground among rank grasses in sloughs or clearings of trees.

Habitat Concerns - Little is known about this species, its populations or habitats in this area. Livestock grazing might be a factor that reduces availability of habitat and populations.

Recommendations
a. Establish a monitoring plan to locate and follow population trends. Inventory activity areas for this species before activities commence.
b. Prepare province plans to identify the availability of habitat and determine Forest-wide condition of population.
c. Studies are needed to understand how this species uses habitats on this Forest.
d. Livestock grazing of grasslands may affect this species.
e. Fire frequency may help maintain or hinder the habitat.
f. Review the cumulative effects of other resource activities on this species.

Condition Trend - Unknown.

Ferruginous Hawk

Habitat and Species Existence - Sightings of this species have been recorded in this watershed. There are 131,000 acres of suitable habitat.

Habitat Definitions - Nesting habitat consists of tall trees along streams, cliffs or rocky pinnacles. Feeding habitat is grasslands, shrublands and open timberlands (shrub-steppe, ponderosa pine and Douglas-fir series). It preys on rabbits, gophers, mice, bats, snakes, lizards, and grouse.

Habitat Concerns - Habitat on the Forest may have been low quality prior to the fires. There may be opportunities to manage habitat to increase populations of this species. Domestic livestock grazing and fire suppression over long periods of time may reduce the prey base for this species. More understanding of the ecology of this species is needed.

Recommendations
a. Establish a monitoring plan to locate and follow population trends. Inventory activity areas for this species before projects commence.
b. Prepare province plans to identify the availability of habitat and Forest-wide population conditions.
c. Conservation plan is needed to understand how this species uses habitats on this Forest.
d. Livestock grazing of grassland may affect prey habitat for this species.
e. Lack of natural wildfire may effect prey habitat for this species.

Condition Trend - Unknown.

Long-Billed Curlew, Common Loon, Greater Sandhill Crane, American White Pelican

Habitat and Species Existence - Likely do not use this watershed, therefore, these species will not be considered futher.

The information in the following table is an estimate of acreages. The only highly-reliable information in this table is the trend of habitat as the acres are estimates based on a poor data base.

Management Indicator Species (Table 2.5)

Pileated Woodpecker

Habitat and Species Existence - This species exists in this watershed. There are undetermined sites established for management of this species. There are 10,500 acres of suitable habitat.

Habitat Definition - Ponderosa pine, Douglas-fir, grand fir, western hemlock and silver fir series provide habitat for this species. Within these series, mature and old growth successional stages are preferred (large trees). Closed canopy, multi-layered stands, large snags, large defective trees, and many dead/down logs of large diameter are needed to provide habitat for this species. The major food source for this species is carpenter ants.

Habitat Concerns - Fire-destroying habitat, timber harvesting, and firewood cutting.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b. Prepare province plans and habitat distribution models to analyze habitat effectiveness, connectivity and availablity of habitat.
c. Leave large snags and defective green trees for nesting.
d. Leave large dead/down trees for prey base (400 linear feet per acre).
e. Maintain canopy closure and large green trees.
f. Reforest as needed to restore habitat.
g. Manage landscapes to reduce the impacts of wildfire.
h. Review the cumulative effects of other resource activities on this species.

Condition Trends - Habitat and populations stable or declining after the burn or if more areas burn.

Pine Marten

Habitat and Species Existence - Marten are known to occur in this watershed. The Forest Plan identified undermined areas for maintaining habitat. There are 24,000 acres of suitable habitat within this watershed.

Habitat Definition - Ponderosa pine, Douglas-fir, grand fir, western hemlock, sub-alpine fir, white bark pine and silver fir series are the series that provide habitat for this species. Within these series, mature and old growth successional stages are preferred (large trees). Closed canopy, multi-layered stands, large snags, large defective trees, and many dead/down logs of a large size are needed to provide habitat for this species. The major prey item for this species is small mammals.

Habitat Concerns - Timber harvesting, habitat-eliminating wildfire, human occupation in/near habitat, trapping, and road access.

Recommendations

a. Establish a monitoring plan to locate and follow population trends. Inventory for species prior to project implementation.
b. Prepare province plans and habitat distribution models to analyze habitat effectiveness, connectivity or availablity of habitat.

c. Leave large dead/down trees to provide habitat for prey base.
d. Maintain a high canopy closure and large dbh green trees.
e. Reforest, as needed, to restore habitat.
f. Manage landscapes to reduce the impacts/likelihood of wildfire.
g. Manage habitat away from residential areas to reduce damage/direct mortality caused by domestic animals.
h. Review the cumulative effects of other resource activities on this species.

Condition Trends - Habitat stable since the Tyee Fire or downward if more areas burn. Population trend may be unknown due to trapping and other human-induced mortality.

Northern Three-toed Woodpecker

Habitat and Species Existence - This species is known to occur in this watershed. Since the northern three-toed woodpecker is attracted to burned forests, habitat for it is estimated to include up to 100,000 acres.

Habitat Definition - Ponderosa pine, grand fir, western hemlock, sub-alpine fir, white bark pine, and silver fir series are those that provide habitat for this species. Within these series, mature and old growth successional stages are preferred (large trees). Snag retention is the key for this species. Their major food source is insects that attack weakened or dead trees.

Habitat Concerns - Timber harvesting of suitable habitat without enough snags created or maintained.

Recommendations
a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b. Prepare province plans and habitat distribution models to analyze habitat effectiveness, connectivity or availablity of habitat.
c. Reforest, as needed, to bring back habitat.
d. Manage landscapes to maintain high numbers of standing dead trees.
e. Review the cumulative effects of other resource activities on this species.

Condition Trends - Populations will be high for the next 5-15 years due to fires.

Mountain Goat

Habitat and Species Existence - This species is a permanent resident of this watershed. There are 35,000 acres of suitable habitat in this watershed.

Habitat Definition - Goats inhabit rocky alpine areas. In the winter, they prefer south-and west-facing slopes with a good mixture of boulder fields and rocky outcrops. Forage sites are in open, shrubby areas and meadows. Mature or oldgrowth forest stands are preferred as optimal thermal cover. Preferred foods are shrubs, forbs, grasses, mosses, and lichens.

Habitat Concerns - Disturbance in winter and during the kidding period. Fire suppression that results in seral stage development of foraging areas.

Recommendations
a. Establish a monitoring plan to locate and follow population trends. Inventory for species before project implementation begins.
b. Prepare province plans and habitat distribution models to analyze habitat effectiveness, connectivity or availablity of habitat.

c. Manage recreation to limit or maintain low levels of disturbance.
d. Use fire to re-establish mountain goat habitat.
e. Review the cumulative effects of other resource activities on this species.

Condition Trends - State-wide trend of habitat and populations is moving downward.

Mule Deer

Habitat and Species Existence--This area contains the largest herd of wintering mule deer on the Forest. There are less than 131,000 acres of deer winter range within this watershed. Before the Tyee Fire (1994), there were about 9,000 deer inhabiting the winter range.

Habitat Definition - Most of the Forest is used by deer as summer range. Winter range is in ponderosa pine, Douglas-fir, and shrub/steppe habitat series. In spring and fall, deer feed on high quality shrubs and forbs. In summer, their diet consists mainly of high quality forage shrubs such as maple, serviceberry, chokecherry, red-osier dogwood, etc. In winter, they eat the best food available (eriogoneum, bitterbrush, ceanothus, and other shrubs, forbs, trees, etc.).

Habitat Concerns - Limited water sources reduce the potential for reproduction. Winter recreation activities such as skiing and snowmobiling impact over-winter survival. Fire suppression reduces forage quality by allowing site conversion and successional invasion by trees into feeding areas. Wildfire kills trees that provided winter thermal cover. Timber harvest eliminates or reduces winter cover. Livestock grazing competes for high quality forage and reduces forage availability in winter habitat.

Recommendations
a. Prepare a Winter Range Management Plan.
b. Reduce livestock grazing on winter range.
c. Reduce winter recreation use of winter range.
d. Manage fire to mimic natural conditions.
e. Use timber management to enhance habitat.
f. Develop additional watering sites.
g. Regenerate trees to provide thermal cover.
h. Manage winter range for a wider variety of wildlife species, including predators such as wolves and cougars.
j. Plant and seed native species to enhance the return of high value winter habitat.
k. Review the cumulative effects of other resource activities on this species.

Condition Trends - 1993 was good and 1994 was poor. From 1995-2030 habitat effectiveness is expected to gradually improve in the fire area. The general trend of the deer herds for the next 10-30 years is to decrease as human activities and ecosystem management are implemented and habitat reduced.

Rocky Mountain Elk

Habitat and Species Existence - Few exist here and they are not being managed to increase in this watershed due to decisions in the Wenatchee Forest Plan and by the Washington Department of Fish and Wildlife, so no further information will be provided.

Primary Cavity Excavators

Habitat and Species Existence - All species of primary cavity excavators occur in this watershed. There are undetermined acres of potential habitat.

Habitat Definition - All forested series provide nesting and feeding habitat for this guild.

Habitat Concerns--Leaving sufficient standing dead trees to meet the needs of this guild where green trees remain. Leaving standing dead trees to survive through to when new green trees can become standing dead. Creating well dispersed dead and down tree habitat throughout the 1994 burn. Leaving sufficient trees for species that require large concentrations of dead down trees. Keeping the wildfire problems within reason while providing standing dead trees and dead/down habitat.

Recommendations

a. Leave large standing trees in sufficient quantity and distribution to provide habitat until replacement snags are available.
b. Provide dead, down material as early as possible and over most of the burn to allow mammals, amphibian amd reptile populations a chance to survive and increase in the first few years.
c. Keep the dead and down material and fire hazard to a moderate to low level.
d. Plant trees and manage them so that the become large enough for primary cavity users as quickly as we can.
e. Coordinate green tree harvest with snag management needs.
f. Evaluate to determine if sufficient dead tree concentration potential has been left for future habitat.
g. Manage woodcutting to prevent loss of designated cavity excavator habitat.
h. Review the cumulative effects of other resource activities on this species.

Condition Trends - The next one to 20 years should reflect an increase in habitat and populations of some species. After that, there should be a dcreasing habitat trend for 20-100 years. After 100 years, the trend will likely begin increasing again.

Beaver/Ruffed Grouse

Habitat and Species Existence - Both of these species occur in the Entiat watershed. There are 28,000 acres of suitable habitat.

Habitat Definition - All successional stages of riparian habitat. Rivers and streams for beaver. Marshes, meadows, and green areas around seeps or springs.

Habitat Concerns - Livestock grazing eliminates grass habitat. Manage to reduce the effects of fires. Manage to reduce the size and effects of wildfires. Keep roads away from riparian habitat.

Recommendations

a. Complete studies to better understand how to manage the riparian habitat.
b. Eliminate grazing in riparian habitat.
c. Reduce effects of erosion from fires on riparian habitat.
d. Plant and seed native species to hasten recovery.
e. Keep roads out of riparian habitat where possible and eliminate roads in riparian where possible.
f. Maintain standing dead trees and down dead trees at high levels in this habitat.
g. Decrease potential of intensive burns by wildfire.
h. Review the cumulative effects of other resource activities on this species.

Condition Trends - Habitat from fires will improve over the next 50-100 years.

Appendix A-2

Entiat Analysis Area
Deer Winter Range

Introduction
Deer winter range has been selected for assessment because deer are an indicator species and there is a specific prescription (EW1) associated with this habitat in the Forest Plan.

This analysis includes all acres of winter range in several watersheds sincewinter range is not restricted to a watershed and a past logical management of deer winter ranges. These areas will be considered in order to determine the desired future condition and subsequent work efforts needed in the Entiat River, Columbia Breaks, and Dinkleman burn areas. Inventories are needed to divide deer information into watersheds.

Habitat Description
Shrub-steppe, ponderosa pine and Douglas-fir series (Open Forest Habitat).

Historic Condition
Historically, this winter range was larger than it is today, probably totalling about 100,000 to 200,000 acres. The winter range included all the lowlands, (i.e., areas that are currently orchards, houses, towns, highways, etc.). Prior to the construction of the dam, the winter range also extended across the Columbia River: It was lower and narrower in winter so animals were able to cross it or use adjacent riparian habitat for cover and forage.

Historically, fires burned across the winter range every 5-20 years. These fires moved relatively fast across the landscape, carried by fine ground fuels such as grasses and forbs. Many unburned patches were left and these unburned patches of bitterbrush, sagebrush, and riparian brushy areas provided cover and forage. Open stands of old ponderosa pine and Douglas-fir provided thermal cover for wintering animals (poor quality). Most good thermal cover was found in riparian strips along rivers and streams. Many drainages had small streams and riparian sites with associated deciduous trees and shrubs. Springs had surface water and wet, grassy/forb areas surrounding them.

There were probably small wetlands, meadows and riparian habitat along streams and springs, which were most likely used by numerous species, such as amphibians. Wetlands, meadows and riparian areas are warmer than other habitats during severe cold weather. These habitats are Critical for deer survival during extremely cold weather conditions.

During the winter, deer foraged largely on grasses, forbs and shrubs in the shrub-steppe habitat.

Wildlife Populations
Historically, there were mule deer, gray wolves, grizzly bears, wolverines, fisher, black bears, bighorn sheep, flammulated owls, bobcats, cougar, sharp-tailed grouse and sage hens using these areas in good numbers. Coyote populations were probably low.

Historically, deer populations varied more dramatically before human settlement and land management. Populations fluctuated from high to low, in response to weather, predators, fire presence or absence.

In the 1950's, high populations of deer were found in this area because predator numbers (wolves, bears, coyotes, cougars, bobcats) had declined due to bounty hunting. Optimum distributions of shrubs and cover grew as a result of fire protection. There was less hunting in the 1940's as most hunters were off to war.

As demonstrated by the high populations of deer in the 1950's, fires likely restricted potential deer habitat and populations. When fires stopped for more than a ten-year period, the potential of the deer winter range

increased. When fires stopped for more than 30-50 years periods the potential for deer winter range likely decreased.

Limiting factors for deer in the past were:

1. weather
2. predators (wolves, grizzly bears, cougar, wolverine)
3. hunting (aborigines)

Existing Condition

Today, the area used as winter range includes about 56,000 acres. The best winter ranges (low elevations) have become less and less available in the last 50 years. Of the available acres, most are owned by the Forest Service, with large acreas owned by the BLM, WDFW, and private individuals. The increasing decline in available winter range acreage (especially at low elevations) for use by deer is a common problem throughout the state of Washington.

Reduced winter range size is attributed to isolation of winter ranges on both sides of the Columbia River, highway traffic on each side of the River, a railroad, variable water levels due to the dam, orchards, residences, deer fences, agricultural use of the lowlands, and various other human uses.

The winter range was heavily grazed by livestock for many years. Fire suppression and livestock grazing increased the shrub component of the shrub/steppe habitat. Bitterbrush stands were decadent before the 1994 fires. These fires also eliminated much of the shrub component and for the next ten years or so, there will be few shrubs available for forage on the winter range. Therefore, deer will depend more heavily on grasses and forbs as they once did for winter forage (see attached graph from 1989-1998 for representation).

Noxious weeds are invading the winter ranges from low elevation areas near roads. Noxious weeds invade where there is disturbance and seed available. Noxious weeds outcompete native grasses and forbs in disturbed conditions and thereby replace deer forage.

Many streams that once ran with water have now gone underground due to past activities. Guzzlers and spring developments have been established to provide water for wildlife and livestock. Riparian habitats now contain more conifers, but fewer deciduous trees and shrubs. In general, riparian habitat quality has declined and roads are located near many riparian sites. The Dinkleman and Tyee Fires are thought to have affected the amount of water available to streams, in addition to bringing streams from the underground to the surface through recutting by water. This change in streams will likely increase the water in the riparian zone and eventually the species of plants and wildlife found in this zone.

Small wetlands, meadows and riparian areas occurred in this drainage and provided Critical deer winter range. The dam constructed along the Columbia River caused a flooding of the area, which eliminated a large amount of this Critical habitat. Habitat that still exists has been significantly modified by grazing and road construction.

There are roads throughout the area and recreational pursuits, such as cross-country skiing, hunting, and snowmobiling, are common in the winter. Road densities range from zero to 7.3 mi/mi^2 in each Fish Production Unit (FPU). Refer to the Wildlife road discussion for specific FPU road densities.

Before 1994, fires had not burned most of the area for many decades. The result of fire suppression and livestock grazing was an increase in shrub (bitterbrush) stands and young, small-diameter thickets of trees and a decrease in grasses/forb populations. The pre-fire condition was heavier to shrubs and old shrubs than has naturally occurred.

Wildlife Populations

A. Bighorn sheep populations are not viable.
B. Grizzly bears, wolverines, fisher, sharp-tailed grouse, and sage hens have been eliminated from the winter range area.
C. Wolves, cougars, bobcats, black bears, amphibians and flammulated owls are at low population levels.
D. Coyote populations have increased.
E. Bald eagle numbers are low but may be increasing.
F. Deer populations are within the range of variability seen under historic conditions.

Most of the winter range managed by the Forest Service was burned by the 1994 wildfires. For about five years before the fires, the deer population averaged about 5000. Some years, lower numbers of animals occurred and only 40 percent of the potential habitat was used. Other years, however, high deer populations accounted for 90 percent habitat use.

In 1994, the Fire eliminated about 70 percent of the winter range from forage and cover production. As a result, approximately 100 feeding stations were constructed to help deer winter survival rates. It is estimated that about 3000 deer will use the feeders. The remaining 2000 deer will survive on the unburned habitat or die from starvation. Many deer will also be killed on the highway. It is unlikely that all the deer will die or all survive which are not fed.

In 1995, it is expected that the deer will not be fed and the habitat will support about 4000 animals through the winter. About a 1000 deer will be at risk of starvation that winter.

By the year 2004, the winter range is anticipated to have recovered to it's pre-Fire carrying capacity. After that the carrying capacity will likely increase to population levels above 5000.

Limitations for mule deer in this winter range are:

1. Weather
2. Critical Habitat is either missing or of low quality
3. Forage availability in winter time
4. Loss of suitable low elevation winter habitat
5. Human related factors--highway traffic, hunting, winter recreation
6. Other predators (wolves, coyote, bobcats).
7. Domestic livestock decrease the availability of forbs and grasses for deer food in winter. (Grasses and Forbs provide more nutrition in winter than do shrubs).

Summary of Historic and Existing Conditions

In conclusion, deer populations have not changed much from historical levels. However, the functions that maintain these populations are different and they operate at different intensities.

1. Before European settlement, the winter range had no owners and operated as one unit; and ecosystem. Now, there are many different owners with various management objectives for the land besides providing winter range. The amount of habitat available for wintering deer has declined significantly.

2. Low elevation habitat (critical and high quality habitat) is becoming more and more unavailable to deer due to towns, dams, orchards, residences, construction, roads, railroads, parks, etc. Other activities are also shrinking the amount and quality of available habitat.

3. Greater numbers of deer are killed on highways, by hunting, and by dogs rather than by predators. Predator control has resulted in more deer for hunters to harvest.

4. Thermal cover from trees and tall shrubs was a minor component of the historic winter range. Old growth Douglas-fir and ponderosa pine stands provided marginal thermal cover. In the past, riparian habitat provided most of the thermal cover and winter forage for deer. Thermal cover may be a stabilizing factor for deer populations.

5. The Tyee Fire eliminated most of the trees and tall shrubs that formerly provided thermal cover.

6. Roads did not exist before European settlement, but now the road density is high throughout the winter range. These roads allow humans access to more areas in the winter. This can cause deer to expend energy that is needed to survive through the winter.

7. Deer populations and other factors affect the predator populations--gray wolves, grizzly bears, cougars, coyotes, wolverine, bald/golden eagles.

8. Deer wintering habitat can be provided in a number of variations, more/less thermal cover, more/less shrubs, grasses and forb components. The mix of forage/cover affects the number of deer that can survive the winter.

9. Deer need water in winter. Some attempt to access the Columbia River for water and are hit by cars and killed on Highway 97.

10. Critical habitat during severe weather has been eliminated and reduced in quality. Critical areas include streams, ponds, marshes, wetlands, springs, riparian ect.

11. Historically, humans travelled onto the winter range to hunt during the winter months. Now, more people are going to the winter range to recreate than to hunt. Deer expend energy escaping from people. This energy expenditure can mean the difference between over-winter survival and death due to starvation.

12. Pre-European settlement times allowed for larger populations of deer over a larger landscape with larger numbers of acres per deer. Today, there are fewer deer over a smaller landscape and the number of acres per deer is less. The future seems to indicate fewer deer on smaller landscapes and about the same number of acres per deer as during pre-European settlement.

13. Deer need food to survive the winter, however, livestock grazing, wildfires, and noxious weed invasions limit food availability.

14. The frequency of pre-settlement fires cycles occurred at such a rate that deer winter range never reached maximum deer-carrying capacity. Fire suppression allowed deer habitat to reach its maximum potential and then decline. It is thought that prior to 1994, the deer winter range habitat capability was declining and the 1994 fires reversed this process. If this is the case, the winter range will again begin to increase toward a maximum carrying capacity.

Projects

1. Purchase or exchange critical pieces of low elevation winter range habitat to increase the effectiveness and size of the winter range.
2. Rehabilitate riparian areas, streams, rivers, ponds, springs and vegetation to historic conditions. Continue to develop and maintain guzzlers and springs to provide water for deer.
3. Implement Forest Plan Standards and Guidelines that limit human activities on winter range.
4. Provide a mix of grass/forbs/shrubs throughout the winter range. Eliminate noxious weeds and maintain or increase native plant species.

5. Provide thermal cover throughout the winter range.
6. Reduce livestock grazing on winter range to provide more food for deer. Key habitats include riparian areas, wetlands, and meadows.
7. Manage fire/fuels so that fires affect 10-30 percent of a winter range per year (instead of 50-90 percent). Use fire as a tool to manage winter range habitat. Consider burning on a regular basis to maintain high quality habitat over a long period of time instead of the peak highs and lows of the past.
8. Reduce open road densities. Relocate roads away from riparian habitat and water sources.
9. Manage habitat to provide for viable populations of other wildlife species (see other species for specifics). This may result in fewer deer.
10. Monitor deer population trends and determine what parts of the winter range are being used each winter.
11. Prepare a Mule Deer Winter Range Management Plan.

Appendix A-3

Entiat Analysis Area
Shrub/Steppe and Open Forest Plant Communities

Bighorn Sheep, Flammulated Owl,
Columbian Sharp-Tailed Grouse, Western Sage Grouse

Introduction

Bighorn sheep, flammulated owl, Columbian sharp-tailed grouse, and Western sage grouse are all sensitive species for the Forest and have habitat similar to that found within the Entiat Watershed. They will be addressed as one group and incorporated into the deer winter range habitat.

By incorporating more than one species into the Big Game Winter Range for the Forest, the Forest Plan needs some modification. The results, however, should be more of an ecosystem approach. Since all information is not known about the incorporation of this group of species, there will need to be further resolution of the desired future conditions as implementation proceeds.

Habitat Definition

Bighorn Sheep - live in steep, open, dry grass/shrub habitats generally below 4000 feet in elevation (shrub/steppe series). Winter range is composed of south-facing open slopes with nearby forests for cover, and sheep habitat overlaps deer winter ranges. Populations of sheep were more abundant on the Forest before pre-European settlement. Populations were eliminted from the forests between 1900 and 1940. Reintroductions occurred in the 1960's and 70's.

Flammulated Owl - This owl mainly eats insects and is migratory or present in this area only in spring, summer and fall. Large moths are a favorite prey for this owl (note there are four times as many Lepodoptern species associated with pine/oak and ponderosa pine series). Preferred feeding areas are sites with low shrub cover. Habitat is open coniferous forest (pine/oak, ponderosa pine and Douglas-fir series). This species uses cavities for nesting. Mature and old growth successional stages are preferred (stands older than 80 years).

Columbian Sharp-tailed Grouse - Habitat is native bunchgrass and shrub/steppe series. Important vegetation is bunchgrass, tall forbs, sagebrush, snowberry, service berry, hawthorn and birch. Winter foods are mainly buds, twigs and catkins from large shrubs and trees. Leks are usually on a knoll or flat spot and have sparse vegetation. Populations usually range out two to three miles from leks.

Western Sage Grouse - Primary habitat is shrub/steppe series. Feeds in early morning around ponds, springs and seeps on leaves of forbs, pods, buds and on insects. Roosts on ground at night. Breeding takes place at leks. The shrub/steppe plant community is also primary habitat for Upland Sandpiper, Ferruginous Hawk and Swainson's Hawk.

Historic Condition

It is not known, but it is thought that:

a. Bighorn sheep once had viable populations between Lake Chelan and Wenatchee. Populations might have ranged from 150-500. Within this watershed, undetermined numbers might have existed. There were 50,000 acres or more of habitat for this species at one time in this watershed.

b. Flammulated owls once had viable populations in this watershed. Populations were thought to be more than 100.

c. Columbian sharp-tailed and Western sage grouse once had populations throughout the shrub/steppe habitat in Chelan County. Each population in this watershed likely contained 100 or more birds. There was once about 30,000 acres of suitable habitat in this watershed.

The area available as suitable habitat for this group of species was the shrub/steppe habitats, which ranged from from where the ponderosa pine and Douglas-fir series began to the Columbia River. Fires burned this habtiat relatively cooly and quickly across the landscape and left patches unburned. There was a mix of shrubs, grasses and forbs. (See deer winter range habitat for more details on shrub/steppe habitat). Shrub/steppe habitat was not the primary habitat for flammulated owls.

Ponderosa pine and Douglas-fir series old growth were habitat for bighorn sheep and flammulated owls. Bighorn sheep used these habitats for cover from heat and cold. flammulated owls used these habitats for feeding and nesting. Cavities in pine trees were an important component.

Predators of these species were gray wolves, bald eagles, other hawks, bobcats, coyotes, cougars and black bears. Some hunting was done by Native Americans.

Limiting factors were weather, predators and hunting.

Existing Conditions
See the discussion under Appendix A-2 for a better description of existing conditions.

Before the burn:

a. Bighorn sheep had a population of 15-20 that may have spent part of the year using habitat in this watershed. Over the last few years, this population has not been increasing. It is thought that this population is affected by diseases from domestic sheep in allotments to the west. A study by the WDFW and the Forest Service is in progress to determine what might be occurring with the sheep. It is thought that disease from domestic sheep might have eliminated bighorned sheep from this area. Hunting might have also had some effects on populations.

b. Flammulated owls still exist in this watershed. There are sightings listed in the spotted owl inventory notes. How many and where has not been plotted or retrieved from those notes. Grazing that reduces forage for insects and harvest of old growth pine stands has decreased these populations.

c. Columbian sharp-tailed and Western sage grouse do not exist in this watershed at this time. Populations of these two species are low in Washington and special actions have been taken to save and increase populations. Hunting and grazing are the two factors that most affect this species.

After the burn:

a. A population of bighorn sheep escaped the burn. As a result of the 1988 and 1994 fires, it is thought that the habitat will be improved for this species in two to five years. Concerns over disease from domestic sheep and low numbers of bighorns are thought to be preventing population viability in this herd.

b. Flammulated owls and their habitat were reduced during this fire. The significance of these reductions is not yet known. It will be 50 or more years before habitat for this species begins to increase.

c. Columbian sharp-tailed and Western sage grouse did not exist, so the fires did not effect populations. The fires will likley provide additional quantities and qualities of habitat for these species. The WDFW has a plan to reintroduce sharp-tailed grouse throughout the state.

Summary of Historic and Existing Conditions

1. Additional work is needed to make bighorn sheep populations viable. Fire may increase habitat, but domestic sheep diseases and low populations are likely limiting the populations.

2. Flammulated owl habitat is significantly reduced. It will be 50 years or more before it begans to increase again. Fire, timber harvest and grazing have reduced these populations.

3. Habitat for Columbian sharp-tailed and Western sage grouse is thought to have been increased by the fires. An opportunity exists, in cooperation with the State, to reintroduce this species to the area.

4. Habitat for these species has been reduced by private land and the change in uses of this land from historic levels.

Projects

1. Align grazing of domestic livestock with the needs of wildlife.

2. Purchase lands to add to the current Federally managed habitat.

3. Manage fire as it occurred naturally.

4. Re-introduce sharp-tailed grouse and sage grouse to this watershed. Cooperate with the WDFW. Prepare a site-management plan. Incorporate needs for other species of wildlife (deer, grouse, bighorn sheep, owls).

5. Once the grazing issue is resolved, introduce additional bighorn sheep to eventually establish a viable population on the north end of the Forest. Prepare a site management plan. Incorporate needs for other species of wildlife (deer, grouse, owls).

6. Prepare monitoring plans for these species.

7. Prepare province level assessments for these species to maintain viable populations, identify habitat availability, and connectivity.

Appendix A-4

Entiat Analysis Area
Riparian Areas

Introduction

Riparian areas are considered to be among the most productive habitats for wildlife species richness and populations. Proximity to water, the edge effect between land and water, and hydrophytic and upland communities, all provide productive green succulent vegetation. Animals of all trophic levels thrive in these locations.

Many species found in the riparian zone are the same as those inhabiting the adjacent uplands. The water and abundance of food in the riparian zone attracts these species. Acre for acre, riparian areas are more productive than the surrounding land. Some species, such as the water shrew, dipper, amphibians, some bats, many invertebrates and plants, are riparian obligates. An obligate species may not spend its whole life in a particular habitat, but it needs riparian habitat at some time in its life cycle for survival or reproduction. The following examples of obligate and non-obligate riparian wildlife may be found in this watershed:

Obligate Riparian Species	Non-obligate Riparian Associates
Water Shrew	Vagrant Shrew
Silver-haired Bat	Little Brown Bat
Muskrat	Jumping Mouse
Beaver	Deer and Elk
Dipper	Ruffed Grouse
Harlequin Duck	Warblers, etc.
Frogs & Salamanders	Garter Snakes
Many invertebrates	Many other invertebrates

Many other species could be considered to be riparian obligates because of their need for an open source of drinking water. Other species, however, are able to obtain sufficient water from dew, the vegetation they eat, or from water released through metabolism.

Management Indicator Species for riparian habitat, which are listed in the Wenatchee National Forest Land and Resource Management Plan are beaver and ruffed grouse.

Note: See also discussions for "Amphibians" and "Special Habitats."

Habitat Definition

Literally defined, the term "riparian" means stream side or stream bank. Because of their importance, the definition of riparian has been expanded to include the biotic communities influenced by water. Some definitions also include the physical and chemical attributes important in hydrologic cycles.

Wetlands are similar to riparian areas in their support of hydrophytic vegetation and associated biotic communities. Riparian areas are often wetlands, while other wetlands are independent of streams. Wetlands and riparian areas are often treated the same or similarly in land management plans. Riparian reserves are defined for wetlands in the Northwest Forest Plan. However, because of the diversity of wetland community types and the variety of species dependent on the various types of wetlands, they are treated in this analysis

under "Special and Unique Habitats." Discussion of riparian habitats in this section will primarily emphasize the riparian management indicator species--beaver and ruffed grouse.

Riparian and wetland habitats are both important and diverse in the biotic communities that they support. For example, the long-toed salamander, is a species that is dependent on small wetlands for reproduction. Larger bodies of water support predators that are destructive to the long-toed salamander and it's larvae (Bob Zeigler, WDFW, personal communication). Tailed frogs require pure, cold, flowing streams in which to reproduce. Beaver impoundments in streams support wetland communities, especially after years in existence, but natural succession in these areas will eventually revert back to forest stands.

Beaver

Beaver are riparian obligates. They require water for escape and are well adapted to life in this medium. They dam streams that are otherwise too shallow to afford them the security cover they require, enlarging and deepening them into ponds in which they can live. Beaver build lodges in their beaver ponds or in the lakes in which they live. They den, reproduce and raise their young in these lodges, which also secure them from predation and inclement weather. They will also burrow into stream banks. Beaver tunnels are common along the larger rivers and many creeks occupied by these rodents. Beaver eat a variety of vegetation, but in forested riparian zones, quaking aspen (*Populus tremuloides*) and willows (*Salix* spp.) are preferred. Management for beaver generally must include these species. Alders (*Alnus* spp.) are commonly used in dam and lodge construction, but are not desired as food. Alders are generally increaser species around beaver colonies since the more preferred food plants decrease from use by feeding beaver. Many abandoned beaver ponds are surrounded by alders, but the willows and aspen are essentially gone.

Beaver colonies are some of the richest areas of biodiversity in northwest forests. Beaver dams raise the water table, killing back the conifers and other plants not tolerant of saturated soils, or they retard the growth of these species into the site. Thus, the open canopy and abundant water near these ponds provide extended riparian and wetland plant communities which, in turn, support a rich and varied fauna.

Ruffed Grouse

Ruffed grouse are found among deciduous trees and shrubs within the forests. Since their habitat grows most commonly along streams, they are most abundant in and near riparian habitats, although they are not riparian obligates. These birds use heavy brush and thickets of young hardwood trees for cover, and they feed on the buds and catkins of deciduous trees and shrubs and on mast, berries, and insects. Their winter food is primarily deciduous buds, catkins and dwarf mistletoe.

The breeding territory of males is usually centered around a drumming log, which is under cover of a small thicket or clump of trees with clear visibility under their lower branches. The need for drumming logs has been questioned, since the males will apparently use a raised mound of earth if a log is not available, and the breeding urge is not apt to be quelled by the lack of a suitable stand. However, the birds are vulnerable during their drumming display, and the proper log under the proper cover should be expected to be a component of fully-suitable habitat.

Conditions and Trends

The trend over time is toward fewer riparian areas due to dams, grazing, trapping of beaver, wells, etc.

Historic Condition

Data available from the National Wetlands Inventory (US Fish and Wildlife Service), at this writing, included only those USGS Quads that are partially within the Tyee burn, so did not cover the entire Entiat and Mad River watersheds. However, a general description of the distribution of riparian and wetland areas is possible. The Wenatchee National Forest Recreation Map shows a relatively high density of perennial streams within the watershed. Six small- to moderately-sized lakes occur in the upper reaches of the Entiat River system,

four of which are in the Glacier Peak Wilderness Area. The National Wetlands Inventory shows wide, riparian-associated wetlands along the Entiat River and a fair density of wetlands in the Mad River drainage, especially in the headwaters. Within the Tyee burn area, approximately 0.5 wetland is indicated per square mile west of the Entiat River. East of the Entiat River, the National Wetlands Inventory shows a large area devoid of wetlands and only a few scattered ones over most of the Tyee burn. The exception to this is in the Lake Creek Basin and Mud Creek, in which beaver appears appear to be numerous. The density of perennial streams appears nearly the same on the east side of the watershed as on the westside of the Cascade Mountains (a lot wetter area than normal for east side of Cascades), except along the ridgetop that divides the Entiat and Chelan Ranger Districts.

Beaver and ruffed grouse, Management Indicator Species for riparian habitats in the Wenatchee National Forest LRMP, are known to occur in the watershed and in the Tyee Burn area.

Beaver

Riparian communities and particularly beaver habitat are often transient in nature, due to natural succession. Hardwood trees and shrubs appear in early seral stages following a major disturbance, such as a wildfire. Beaver move in and develop their habitat; the raised water table behind their dams retards upland plant species succession. Eventually, the beavers' food source is used up faster than it can regenerate against competition from increasing alders and other less-palatable species. The colony then diminishes in the wake of declining habitat quality. No longer repaired, the dams leak, the water table lowers, conifers invade and succession proceeds back to softwood forest until the next major disturbance sets it back to early seral stages.

Ruffed Grouse

Habitat for ruffed grouse in the Entiat/Mad River Watershed would be expected to be found along the streams and wetlands in forest areas where hardwood trees and shrubs are common. Typically, they would not be expected to be common on the southerly or westerly aspects in open ponderosa pine forests.

Additionally, ruffed grouse would not be expected in extensive mature or old-growth forests, even in the riparian zone. As conifer succession progresses, the hardwoods on which ruffed grouse feed diminish, and as the stands mature, the dense cover used by these birds is no longer available. Disturbances within riparian and the more mesic upland forest stands maintain habitat for this species. Old logs left on site become their drumming logs after young trees cover them and the lower branches thin out. A proper mix of conifer and hardwood edge with large woody debris on the ground is needed for breeding and winter habitat. Succulent ground vegetation and a source of insects provide spring and summer food for adults and their broods.

Parts of the watershed had burned previously, and much of it had been managed for timber production. This created the necessary edge for ruffed grouse in the forested plant series. Timber harvest along riparian areas, even though not in them, would have created suitable edge habitat for this species. However, too much slash disposal or site prep would have reduced the suitability if insufficient drumming logs remained. Extensive stands of pole to saw timber-sized conifers, with reduced early successional (deciduous shrubs and trees), edge would also reduce suitability if timber management rotations were not properly dispersed through time and space.

Existing Condition

In the Tyee Fire of 1994, 32 percent of the watershed burned. Depending on the patterns of the burn and the fire behavior in the riparian areas, this could be beneficial to riparian-associated species over time. While the immediate effect may have been devastation, the establishment of low ground cover and an increase in insects available (in the openings) to ruffed grouse broods will benefit those birds and other associated species for a number of years. The natural succession of hardwood shrubs and trees and the resulting

increased stream flows can be expected to benefit both the beaver and ruffed grouse. Additionally, as discussed above, establishment of beaver and their activities is beneficial to numerous plants and animals.

Summary of Historic and Existing Conditions

While riparian habitats are temporarily destroyed by catastrophic events, such as the Tyee Fire, these events can be beneficial by retarding succession to primary stages. This in turn creates habitat diversity within the riparian zone of the watershed. The two Management Indicator Species for riparian habitat in the Wenatchee National Forest LRMP, beaver and ruffed grouse, are apt to benefit from early and mid-successional stages as the stands recover. Concerns about this type of disturbance, are for maintenance of soil, soil productivity, stream channel integrity, and water retention in the drainage. Beaver will contribute to the maintenance of these characteristics, once established. However, protection of these resources will be necessary in the first few years following a fire--until vegetation is reestablished.

Projects

1. Stabilize slopes and stream channels for short-term protection of soils, aquatic habitats and water retention within the drainage.

2. Protect road beds and provide drainage to reduce erosion. Dissipate runoff water and its velocity when approaching stream crossings.

3. Seed areas, susceptible to sheet erosion and gullying, with short-lived annual vegetation for short-term soil protection and prevention of noxious weeds without introducing long-term non-native vegetation.

4. Monitor recovery of riparian trees and shrubs. Where needed in areas devoid of stabilizing vegetation, plant willows and other hardwoods that are beneficial to beaver and ruffed grouse.

5. Close and relocate roads within riparian areas to be outside riparian habitat wherever possible.

6. Create snags in riparian areas where the number of natural snags is insufficient.

Appendix A-5

Entiat Analysis Area
Primary Cavity Excavator (PCE) Habitat

Introduction

Primary cavity excavtor (PCE) habitat is important for many species of wildlife and is part of the functioning of an ecosystem. PCE habitat should be provided on a stand, as well as landscape basis. Some minimum level of snags should be provided on a landscape and some minimum level should be provided on a watershed basis. **According to the Northwest Forest Plan that figure is 40 percent (page C-42), however Wenatchee National Forest Plan standards and guidelines for specific management areas may be more restrictive.**

Habitat Definition

Primary Cavity Excavator habitat is standing dead trees or live defective standing trees that provide cavities or potential cavities for vertebrates. Additionally, dead down trees that provide cover, food, and dens on the ground are suitable.

All forested series provide nesting and feeding habitat for this guild. High elevation habitat often does not provide large snags (15"+ dbh). This habitat, in turn, does not provide for many species that require large diameter snags.

Historic Condition

Each series provides snags and down material in different ways and numbers since each functions somewhat differently. As a result, the wildlife species associated with each series is different. The same concept is true of successional stages within a series. The wildlife species changes as the dead tree component and the size, shape, and densities of the green trees change. Providing site-specific stand information is a complex problem. It is at this point that assessment at the landscape level becomes a challenge.

Shrub/Steppe (meadows and habitats without trees) - Do not have high densities of trees or shrubs, but some green trees invade into these habitats and then die. Species such as the northern flicker, Lewis woodpecker, flamulated owl and bluebirds prefer dead trees in open grassy conditions (there are others). A clearcut of the tree series often functions like these habitats, for a short period of time.

Ponderosa Pine Series - Generally, stands of well-spaced, large old trees. Occasionally, there are smaller and younger trees in the stand. The large, old pine trees are often defective. They have fire scars, large broken-out limbs, dead tops, and part of the tree is dead as well. There are few standing dead trees but those present have usually been around a long time and are very large. There are few dead down trees on the ground and low amounts of debris from the trees. Crown closure is 50-70 percent, with shrubs, grasses and forbs growing slowly under the trees. Due to competion between plants, a significant part of the ground surface has no plants or trees growing directly on it, however, the site is being fully utilized.

In the pine sites, few trees are being replaced, few are dying and fires are underburning the area thus eliminating the down material, shrubs, grasses and forbs. Snags are not found on every acre but cavities are abundant in live old trees. In a sea of old growth, one to five percent of the landscape contains young tree stands in patch sizes ranging from 1/10 to 20 acres in size. Young stands are created by insects, fire, and disease and contain large numbers of large standing dead trees and dead down logs with most of their limbs missing.

Bats and flammulated owls are found in large numbers in old, open pine stands. These stands contain cavities for roosts and nests, insect populations on which to feed and water for drinking (springs, ponds, streams and wetlands). Insects have high populations and four times as many moth species are found in the ponderosa pine series. Populations of wildlife are dependent upon the insects and tree stand health may be as well.

Douglas-fir Series - Generally, an old growth stand with a mix of ponderosa pine and Douglas-fir trees (ponderosa pine being the most abundant tree species). These stands look and function in a manner very similar to the ponderosa pine series. The difference is that often larger areas are comprised of young stands where older trees have been killed by fire. This occurs because Douglas-fir trees are more vulnerable to fire and burn hotter than ponderosa pine trees.

There are more standing dead trees and more trees on the ground in these younger stands than in the younger pine series stands. There is about the same amount of dead standing, dead down and live defective trees as there are in the old growth pine series.

Grand Fir Series - Generally, a mix of tree species with ponderosa pine being the dominant species. These stands look very much like the Douglas-fir series but have larger trees and greater numbers of them. The snag numbers are higher due to a higher mortality rate of standing dead trees, which results in more dead down logs. Grand fir is more susceptible to fire effects than the Douglas-fir or ponderosa pine series, so larger areas are comprised of young stands that have occurred as a result of burns. Down material and standing dead tree numbers occur in high numbers in the young stands and there are large amounts of small limbs associated with them.

Western Hemlock Series - Generally, a mix of tree species with Douglas-fir and western hemlock dominating. This series grows where it is wet and therefore little, if any, underburning by fire. This series will go long periods of time without major stand-replacing fires (200-1000 years). This is likely due to the wetness of the sites. For this reason, the landscape resembles old growth, with some small patches of young stands or whole landscapes of young stands with remnant old growth trees with small stands of old growth. The old growth stands have very large trees and are multi-layered (two to three) with a well-developed shrub layer. The young stands have a high density of fairly even-aged heights and diameters and low shrub amounts.

There are high numbers of large snags in aged hemlock stands and more soft snags in the young stands than the old. Because of the large diameters of the trees, these snags often stand 100-200 years and last on the ground for 100 years or more. The young and old stands also contain small-diameter dead trees at higher densities than other series, which will last for 10-30 years and then fall. These smaller trees last for 10-30 years on the ground and then decay into the soil. The ground under these trees is a mix of sizes of decayed dead logs. There are high mushroom populations associated with this series.

Silver Fir Series - Similar to Douglas-fir series except the trees are much smaller and do not stand as long as snags or down material In other words, an examination of the ground would show some moderate- and small-sized material in smaller amounts in various stages of decay.

High elevation series (lodgepole, subalpine ect.) - All have similar responses. They contain dense, slow-growing stands of small-diameter trees.

These stands produce small snags that do not stand very long. After snags fall to the ground they disappear quickly. Therefore, there is little down material on the ground at any moment in time. There are fewer animals using PCE habitat in the high elevation stands.

The landscape is large stands of old or small trees. Fires burn more slowly but for longer periods of time. Stands that are burned usually suffer high mortality rates.

Existing Condition

Tree Harvesting

During the last 50 years, ponderosa pine trees have been logged from the ponderosa pine, Douglas-fir and grand fir series. It began with the removal of trees for houses, then clear-boled trees for the manufacture of apple boxes, then for the large, easily-accessible trees for local lumber mills and in recent years large trees for regional lumber mills. The first entry was for trees with clear lumber, and finally trees were removed to make way for the new young fast-growing trees. During these times some snags were left, but these stands posed safety problems during re-entry, so most snags fell. Woodcutters prefer snags (especially large ones) for firewood; falling and removing them from the forest. The result was most of the large old-growth ponderosa pine trees and habitat being harvested. This eliminated the function these trees had of providing cavities in large trees.

Removal of old and defective large pine trees eliminated cavities for flammulated owls, bats and other species. Grazing reduced the ground vegetation that provided the moths and other insects. As a result, bat populations and flammulated owl populations have been greatly reduced in this watershed and throughout their range. This led to their listing as "sensitive" and may lead to a Federal listing of "threatened and endangered."

As time passed, western hemlock stands were also harvested by clearcutting, and lodgepole stands were clearcut with few or no snags left remaining in the units. The idea was that a large enough population of trees would exist that by the time all the current stands were harvested, a new population of trees would be available. In 1989, the Forest established snag management guidelines, hence, consistent snag and green tree leaving has only been occurring for a short period of time.

Regeneration

As the old trees were harvested, young trees naturally "seeded in" due to domestic use of the grass/forbs (reducing tree competition) and disturbance of the soils (made a good seed bed for young trees). Grazing allowed many young trees to grow in the shrub/steppe, ponderosa pine, Douglas-fir and grand fir series. These were eventually precommercially thinned and acted as excellent thermal cover for deer. The trees were small in diameter, provided few snags of adequate size for cavities, and did not last long as dead down material.

Fires

The 1970 fires in this drainage burned many thousands of acres and most big trees were salvaged. An examination of this fire area now shows almost no snags (34 years later) and the new trees are 2-6" in diameter. In other words, these acres no longer contain primary cavity excavator habitat. A mosaic of islands of green trees and partially green trees were left by the fire. These areas were also salvaged. As a result, there are few snags in these stands. Some of this fire area burned again in 1994. These areas have no standing dead trees and no down logs to provide any potential habitat.

In 1988, the Dinkleman Fire burned another part of this watershed. Four thousand acres of large dead trees were salvaged. Again, in 30 years, this fire area will contain low snag numbers. In 1994, still another part of this watershed burned. Approximately 40,000 acres sustained 100 percent tree mortality. Another 40,000 acres contain some green trees and another 60,000 acres or more have a good component of green trees remaining.

Thousands of acres harvested between 1950 and 1989 have less-than-viable population of snags. Many of these sites were burned in the 1994 fires and most snags that remained were burned as well. The trees that remain are dead and too small to be available for snags in ten years, as they will have already fallen.

At the moment, there are many standing dead trees throughout the fire area, which are providing far more habitat for PCE species than they can use right now or in the next 20-40 years. As a result, salvage logging

is likely to occur. Most of the existing dead trees are less than 20" dbh. Therefore, the only snags standing in 20-30 years will be over 20+" dbh.

New trees will be planted and natural seeding will establish new stands that will provide large enough diameter green trees which will become snags in 50-120 years. This will all depend upon the series, stocking and site potential of the area, however.

Many areas of the Forest and this watershed are at high risk of fire and will likely burn in the next few decades. The 1994 fire area may reburn as soon as 20-40 years from now.

The cumulative effects of timber management and wildfire are that this watershed will likely have low populations of snag-using species in 30-120 years. The total effect and viability determinations will depend upon what salvage activities occur. This problem may extend into adjacent watersheds. Therefore, a large part of the Forest may have viability concerns for snags in the future.

It is certain that many acres in this drainage do not currently have a large enough quantity of snags or green trees to meet the Forest guidelines. It is known that many 40-acre snag management areas (SMAs) cannot now meet the minimum standards of the Forest Plan. It is also a certainty that a larger number of SMAs will not meet Forest Plan and Regional Standards 30 or more years from now. It may be that some Fish Production Units (FPUs) cannot meet Regional direction and cannot provide viable populations, as well.

When logging occurred, a lot of dead and down material was on the ground and more was established. Some was sold, some was burned and some was picked up by woodcutters, however, there was still an abundance. The 1994 fires eliminated 90-95 percent of the down wood over an area of 140,000+ acres. This represents 45 percent of the watershed. This is quite significant to populations that use down logs for food and cover. Many thousands (and quite possibly a million or more) of small animals died in this fire.

As dead trees fall, this habitat will be replaced and the small mammal populations (e.g., snowshoe hares, chipmunks, voles, ground squirrels, shrews, etc.) will slowly be replaced (10-30 years). As the small mammal populations increase, predators (bocats, lynx, coyotes, bald eagles, peregrine falcons, red-tailed hawks, snakes, etc.) will again be able to find food and increase in population.

Down logs, grasses and forbs will produce insects and mushrooms, which are the food sources of small mammals and birds.

Falling large trees to the ground, piling slash and stacking small trees will place a quantity of this material on the ground quickly. This would allow these populations to rebuild rapidly. The science regarding the numbers and distribution of this is not well developed, but conservative estimates can be made which will help considerably. For example, it is known that mammals are territorial and that if the piles of down material are distributed, an increase in animal production will occur. It is also known that if water is nearby the populations and species are higher, and additional animals can be expected to occur from this treatment.

Approximately 40 logs, 10 feet long and averaging 8" dbh per acre were felled over 14,100 acres of the fire area during the fall of 1994 for erosion purposes. In addition, over 100,000 acres were seeded with grasses and forbs to mitigate erosion. As vegetation returns this spring, some habitat for small mammals will develop, and in locations where down logs appear, a big increase in rodent populations is expected.

Summary Comparison of Historic and Existing Conditions

1. In pre-European times, whenever a large wildfire consumed a stand, the large dead trees carried through into the new stand as snags and down material. This allowed structure in young stands and wildlife use at an earlier stage of the stand's development. Selective harvest and salvage of the largest trees eliminated the large snag component from timber stands. Since, snag diameter is inversely

related to the time they remain standing, this creates a gap following catastrophic wildfires between snag fall and availability of large trees for snag recruitment.

2. Stands with large old pine trees functioned differently for PCE than did stands dominated by large fir trees and stands of small size at high elevations.

3. The number of wildlife species using low elevation pine stands is much greater than that using the higher elevation series. The amount of defective tree habitat standing was larger(more cavities in live trees) as well. When these stands burned, large numbers of large diameter trees were left. As they fell (50-200 years), underburning returned to the stands and reduced the down material to a small amount. The underburning served to reduce the live tree densities, which allowed a few pine trees to reach large size classes. Small snags and down material were only important for a short period of time (10-40 years).

4. The mid-elevation stands had a moderate number of wildlife species and most of the cavities (defective trees material) were located in snags and down logs of various sizes. When these stands burned, a lot of material remained, both standing and dead, to carry into the new stand. This material served as protection and as a nutrient base for the next stand. The large dead trees can be found 100-300 years after the fire in the new stand. Small snags and dead material did not play a major role in the replacement stands.

5. High elevation stands contain about 50 percent of the wildlife species that are found in low elevation stands. Snags are small and stand for only short periods of time (10-40 years). Down material does not last long because it is small, and the new stand has little carryover from the previous stand. The role of dead and defective tree habitat is not as important for wildlife species.

6. Timber harvesting in the Entiat and Mad River areas has significantly reduced PCE habitat and the potential for PCE habitat after fires. Large areas will be devoid of standing PCE habitat in 50-100 years. This function will not completely return to these stands for 200-400 years. Since there was once large amounts of PCE habitat over the landscape, this represents a major change in the processes and functions of the forests of the future.

7. Fire has killed the existing stands and degraded the population potential for PCE habitat that remained following logging activities.

8. Salvage of large dead trees from the 1970 and 1988 fires has added to the problems of future potential populations of PCE habitat.

9. Small dead trees (less than 20" dbh) do not provide for the long-term needs of primary cavity excavators, which will be necessary when the new stands reach 4-12" dbh.

10. The 1970, 1988 and 1994 fires eliminated the potential for standing and down PCE habitat for 50-100 years and maybe longer.

11. Reductions in grass and cavities in the ponderosa pine, grand fir and Douglas-fir series over the whole range of these habitats have resulted in a reduction in numbers of bats and flamulated owls and concern over the future viability of the species. This is also exacerbated by the fact that habitat was greatly reduced in this drainage as result of timber harvest activities. The fires of 1994 also contributed to the reduction of habitat.

12. It appears that PCE habitat may be below established levels over large areas of the Entiat Mad River Watershed. This a major problem in the lower elevations and in areas that have been burned by fires. Higher elevations and areas burnt by fires may have acceptable levels.

Projects

1. Before any activities occur to reduce PCE habitat, an inventory of standing dead trees should be completed for the entire watershed. From this information, recommendations for leaving dead trees can then be developed.

2. Establish a monitoring plan for PCE habitat within this watershed. Also, plan to monitor species to measure response levels. Recommended monitoring species are woodpeckers, bats flamulated owls and moths.

3. Prepare an assessment of PCE habitat within the province. This should help with management decisions concerning this watershed and how other watersheds fit into the viability of wildlife species. It is likely that significant problems will be identified for some species throughout the province.

4. Leave standing greater numbers of large dead trees in ponderosa pine, Douglas-fir and grand fir series. Leave trees with existing cavities.

5. Find and implement new ways of supplementing the standing large dead tree population. (For example--Haul in large trees from other places and stand them up, cable large trees on site to hold them up, cut out the tops of large trees to get them to stand longer, make and bring in artificial trees with cavities etc.)

6. Establish and maintain nest boxes for wildlife.

7. Reduce the potential for another large catastrophic fire (for 100 years or more) to reburn the areas burned in 1988 and 1994, in order to maintain PCE habitat.

8. Reforest the stands that had trees historically. Manage stand densities to get large-diameter trees (for snags) as quickly as is reasonable.

9. Do not reforest stands that did not historically have full stocking, but leave snags to represent the open/snag species needs. Large snags that last a long time are desired.

10. Grazing activities need to be reviewed in order to manage forage apportionment between ungulate species and livestock.

11. Studies should be established to determine the amounts of dead and down material that should be left after a fire and the effects on wildlife populations.

Primary Cavity Excavator (PCE) Habitat Management

The Forest Service has been working on modeling snags and dead, down tree habitat for over 25 years. During that time, data and modeling have increased significantly. For the Entiat/Mad River, the timeframe given to incorporate and document data and assumptions was short. Therefore, it is possible that an error or an instance of undocumented information occurred.

To begin with, this assessment assumes that the standards and guidelines for the Wenatchee Forest Plan and the Northwest Forest Plan will be followed. This assessment tries to provide information to be used for PCE habitat, in addition to existing documents, to facilitate the implementation process. (For a list of reference sources for PCEs, refer to Figure A-5.5 at the end of this section).

Since providing snags and dead down trees for intensively burned areas has not been viewed in a manner different from a normal project, this assessment will show the need for a different solution in intensively burned areas. The goal is to present the information in a manner easily assimilated by managers.

When is there a catastropic event (from a snag stand point) and when is there a normal green/snag tree project? A normal project occurs when there are green trees of sufficient numbers and sizes to replace snags as they fall. In a catastrophic event, enough green trees are not available without special actions (special actions may not even be enough) to bridge the gap until the site returns to a normal green tree project.

When is a Series Considered to have Sufficient Green Trees for Replacement of Snags
Table A-5.1

Series	Acres SMA	Total dbh	Green Trees
Douglas-fir	40	15 inches	400
Ponderosa Pine	40	15 inches	400
Grand Fir	40	15 inches	240
Western Hemlock	40	15 inches	240
Lodgepole Pine	40	12 inches	800

SMA = Snag Management Area is 40 acres or less.

Table A-5.2 (below) shows dead standing trees at potential population levels for a 40-acre area, where green trees are available as replacements. In this table, 123/45 means decay levels 1,2,3 (hard snags) slash then decay levels 4 and 5 (soft snags).

Snag Management in Green Tree Stands
Table A-5.2

DBH (by series)	20% PP	40% PP	60% PP	80% PP	100% PP
Grand Fir & Western Hemlock					
25" +	5/0	10/0	15/0	20/0	26/0
17" +	12/6	24/12	36/18	48/24	60/29
15" +	19/5	38/10	57/15	76/20	95/24
11" +	0/0	1/1	1/1	2/2	2/2
Ponderosa Pine & Douglas-fir					
25" +	5/0	10/0	15/0	20/0	26/0
17" +	12/4	23/8	37/12	49/16	58/19
15" +	30/10	60/20	90/30	120/40	150/50
Lodgepole Pine					
15" +	46/16	92/31	138/47	184/63	230/77
11" +	4/1	8/2	12/4	16/5	19/6

Providing Snags in an Area that has been Modified by a Catastrophic Event

Catastrophic events eliminate green trees and the immediate potential to grow future snags for a significant time frame. The most common being intensive burns caused by wildfire. When dead standing trees cannot be replaced as they fall, the following tables and concepts become applicable.

Concepts

1. Snags need to be present for 50-120 years following a catastrophic event.
2. Leaving the largest snags available provides the best conditions under which to maintain PCE habitat until green trees again provide adequate-sized snags.
3. Leaving three times as many snags as the desired level, in stands with green trees, helps maintain enough snags to bridge the gap until green trees are adequate enough in size to provide snags. Two-thirds of the snags fall between creation and the time when new snags from adequately-sized green trees are provided.
4. Manage stocking levels of green trees to provide large-diameter green trees that can become snags as soon as possible.
5. The tree species that stand the longest after death in order of longest standing--Douglas-fir, larch, ponderosa pine, grand fir, lodgepole pine.
6. Leave the dead trees containing the most cavities. Fire eliminates most cavities and are the most limiting factor for many wildlife species following a fire.
7. Topping snags at 30-50 feet increases the time a snag will remain standing.
8. Provide nest boxes to replace cavities lost during the event.
9. Monitor and complete studies on fall rates and amounts of snags to be left after an event. These can then be used to replace the estimates that are presently being used.
10. Low elevation habitats have more wildlife species associated with habitat than upper elevations. Higher site productivity appears to affect population numbers and not numbers of species.

Snags Needed in Stands Experiencing Catastrophic Events
Table A-5.3

–Trees Remaining Immediately After Fire–

DBH (by series)	20% PP	40% PP	60% PP	80% PP	100% PP	PP 40 - 120 Years Hence
Grand Fir & Western Hemlock						
Scenario 1 25" +	42	83	125	166	208	40
Scenario 2 25" +	104	208	312	416	546	100
Scenario 3 25" +	14	28	42	56	70	13
17" +	12	24	36	50	60	
15" +	22	44	66	88	109	
11" +	0	1	1	2	2	
Ponderosa Pine & D-fir						
25" +	140	281	421	561	702	100
Lodgepole Pine						
15" +	138	276	414	552	690	0
11" +	11	23	34	45	57	

Dead and Down Trees

The structure of dead and down trees provides cover and food for many species (mice, squirrels, rabbits, etc.). Many of these species are prey for hawks, owls, snakes, and carnivorous mammals. Food supplies with the proper cover regulate predator populations.

Wildfires eliminate most of the structure provided by logs. It not only eliminates the habitat, but often the animals as well. The quickest way to "restart" a fire-affected system is to provide habitat for small animals and invertebrates which, in turn, support the larger predators.

Prey populations respond quickly as habitat recovers, and in response, predator populations increase. When the population begins to recover, the functions of an ecosystem do as well. The more acres of burn on which structure for dead and down material is established early, the earlier that wildlife recovery will occur.

General Concepts on Providing Dead and Down Tree Habitat

1. Provide dead and down tree habitat on the same units as snags. Snag Management Areas (SMAs). These are 40-acre or smaller areas.
2. The numbers listed under "linear feet of logs" in Table A-5.4 are the minimum, interpreted from forest plans. The slash piles and artificial log categories are options to compensate where insufficient logs exist.

3. Prey species are found in higher numbers near water, as are most organisms. Therefore, providing more down log habitat near water would be beneficial.
4. Because most vertebrate species are territorial, distributing the down dead tree habitat over the whole SMA would increase potential populations.

For a 40-acre area where green trees are NOT available as replacements, Table A-5.3 shows dead standing trees at potential population levels. Soft snags are not shown in this table since they are not available (they burned in the fire). When figuring snags in future years for this catastrophic area, there will likely be soft snags. Use soft snag numbers from green tree tables and hard snags from catastrophic event table.

Assumptions for Table A-5.2: 25"+ dbh means the largest trees on the 40-acre SMA. Also, 67 percent of 25"+ dbh trees will not be standing in 60 years. (Data indicates this may be a good assumption but real data by species may be more or less.)

Scenarios

There are a number of scenarios for providing snags. Each has different effects on other resources and on PCE populations.

SCENARIO 1 - Leave 100 percent potential population level of the largest diameter snags in SMA now. This scenario will provide a 100-40 percent potential population level until green trees are available for the size of snags needed. This may work for 40 years. Taking into consideration the uncertainities of the information on which this is built, there is a high risk that the area will not conform to the Northwest Forest Plan and will not meet the Forest plan in many other areas.

SCENARIO 2 - Leave 262 percent of the desired potential population (PP) level of the largest diameter snags in SMA now. This provides the best chance of maintaining PCE populations until green trees are available for the size of snags needed. This will likely meet the Northwest Forest Plan and the Forest Plan standards for a fire.

SCENARIO 3 - Leave 100 percent potential population level of all size diameter snags. This scenario may work for 20 years in a fire area. Since the area of the catastrophic event is large (40,000-80,000 acres), this will not meet Forest Plan or Northwest Forest Plan standards.

SCENARIO 4 - Other scenarios can be developed, such as "cutting the tops out of those trees mentioned in Scenario 1" and leaving fewer trees. Costs and safety problems increase for these alternatives. In fact, leaving existing larger trees is more cost effective.

In Table A-5.4, the recommended levels of dead down material for different series are provided. These numbers are estimates and research should be completed to verify its effectiveness and the kinds of dead down trees which should be provide in the future.

Dead, Down Tree Recommendations
Table A-5.4

Series	Feet of Logs	# of Slash Piles	# of Artificial Trees
Western Hemlock	9600	10	10
Grand Fir	7200	10	10
Ponderosa Pine	4800	5	5
Douglas-fir	4800	5	5
Lodgepole Pine	7200	10	10

Down Logs are defined as 16+ feet long and 16" in diameter. Quantities are per 40 acre SMA. "Feet of Logs" is in linear feet.

Slash Piles are defined as 64 cubic feet or a pile of small tree material that approximates a 4' x 4' x 4' pile. Pile arrangement can be any shape, since it us unknown which might provide the best environment.

Artificial trees are defined as a group of small diameter trees without limbs, stacked parallel to each other to form a dead tree-looking structure, sixteen *plus feet long, two feet high and two feet wide.*

Created structure such as those suggested above will likely provide hiding cover for such animals as chipmunks and lizards, but whether or not they will function in the same manner as a large log to hold moisture and support fungi, invertebrates, etc., which depend on specific characteristics of those logs, has not been determined.

The linear feet of logs in the above table is based on the minimum specified in the Northwest Forest Plan, and interpreted for these vegetation series. The 120 linear feet per acre is prescribed as an interim quantity for the east side of the Cascades in Washington, etc. For this analysis it was interpreted to mean 120 linear feet in dry open forests, and a greater amount should be maintained in more moist forest types where greater amounts of large woody debris occur naturally. Therefore, 240 linear feet per acre, as prescribed for Western Washington, was used here for western hemlock series, and the average between the two quantities was used for the grand fir and lodgepole pine series.

PCE Reference Source List
Appendix A-5.5

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Appendix A-6

Entiat Analysis Area
Roads and Trails

Introduction

While some wildlife species are not impacted by human activities associated with roads, trails, and campgrounds, other species are highly vulnerable to these disturbances. In general, a 100-foot area on either side of roads and trails or ¼ mile from campgrounds, is the area normally impacted by humans. Some species are disturbed within ¼ mile of roads/trails and ½ mile around campgrounds. The species most sensitive to humans activities are impacted when they are within ½ mile of roads/trails and ½ mile from campgrounds.

For this analysis, wildlife species will be reviewed as a group in order to calculate the acres impacted. Projects will be planned by considering those that would most likely be impacted. Areas that are designated as winter range, on the attached maps, have not been "ground-truthed." These areas will need further inspection in order to adequately define the actual winter range limits.

Habitat Definitions

The species that will be considered in this assessment are mule deer, grizzly bear, gray wolf, wolverine, fisher, mountain goat, and North American lynx.

Historic Condition

Historically, there were no roads in this watershed, although there were trails used by Native Americans.

Animals used low elevation areas that were relatively warmer than the uplands for wintering. Large numbers of animals were concentrated in these areas during the winter and low to moderate wildlife populations used these areas in the summer.

In the summer, high elevation habitat was important for wolves, wolverines, and grizzly bears. These sites provided high quality food and cover to raise young. Some species remained at high elevations year around; weather being the most limiting factor. It was difficult to survive in this environment, but the additional need in current times for animals to escape from humans added an additional threat to survival (escape from danger and expenditure of energy to escape). Populations of species that inhabited high elevation areas (mountain goats and lynx) were low in number.

Mid-elevation habitats were used as migration corridors and travelways that extended from low to high elevations. Moderate populations stayed at mid-elevations or used them during the summer.

The following table describes the season of use for selected wildlife species.

Wildlife Use of Subwatersheds (FPUs)
Table A-6.1

FPU	Deer	Grizzly Bear	Gray Wolf	Fisher	Mtn. Goat & Lynx	Importance to All Animals
Lower Entiat	W 90%*	ES	W	Y		W
Lower Mid-Entiat	W 15%	ES	W	Y		W
Upper Mid-Entiat		T	S-T	Y		T
Upper Entiat		S	S-T		Y	Y
Headwaters Entiat		S	S-T		Y	Y
North Fork Entiat		S	S-T		Y	Y
Mud Creek	W 95%	ES	W	Y		W
Stormy Potato	W 50%	ES	W	Y		W
Preston		T	S-T	Y		T
Silver		S	S-T		Y	Y
Tommy		S	S-T		Y	Y
Roaring	W 15%	ES	W			W
Dinkleman	W 10%	ES	W			W
Lower Mad		T	S-T	Y		T
Middle Mad		T	S-T	Y		T
Upper Mad		T	S-T	Y	Y	Y
Headwaters Mad	W 5%	W-ES	S-T-W		Y	Y

* Percent of FPU

Time of Year of Use

W = Winter Use - Nov 1 - April 15
ES = Early Spring-March/April
S = Summer
T = Travel/Migratory
Y = Year Long

Existing Condition

Roads were constructed in this drainage when white settlers first moved in. From that time until about 1989, road densities increased for the purposes of accessing private lands, harvesting trees and grazing on National Forest Service lands. Roads are also used for recreational access and activities.

There were probably trails in this watershed that were used by Native Americans, trappers, and explorers; although none are noted in the literature. Today there are many miles of trails, within the watershed, that are used for recreation activities. The highest trail densities are in the less-roaded and less-managed, high elevation portions of the watershed.

There are several campgrounds that were built to provide campsites for Forest visitors. Other visitors camp in undesignated areas (dispersed camping). Camping is generally associated with roads or trails as these usually provide access to campsites.

Since 1989, when the Forest Plan was completed, plans were developed to close roads. Implementation had proceeded as scheduled, until the occurrence of the 1994 fires. Some roads were constructed and still others were reopened and have not yet been reclosed. Additional roads may need to be constructed in order to facilitate timber salvage and accomplish habitat improvements.

The following table shows the densities of roads and trails and the percentage of habitat impacted, in general. Specific projects need to address specific species and refine the lines of use as Fish Production Units (FPUs) is a general designation for road densities.

Road and Trail Densities - Entiat Watershed
Table A-6.2

Name	FPU #	FPU Acres	Road Density[1]	Revised Road Density[2]	Trail Density	Road & Trail Acres Affected[3]	Percent Affected[4]
Lower Entiat	03A	24,704	3.29	(2.99)	0	2,963	12
Lower Mid-Entiat	03B	23,869	3.10	(2.66)	.14	2,815	11.8
Upper Mid-Entiat	03C	14,968	1.84	(1.47)	.38	1,207	8.1
Upper Entiat	03D	17,763	.57	---	.81	901	5.1
Headwaters Entiat	03E	25,881	0	---	1.15	1,079	4.2
Mud Creek	03F	14,611	3.73	(2.59)	.19	2,057	14.1
Stormy Potato	03G	12,054	2.67	(2.22)	.20	1,274	10.6
Preston	03H	7,560	6.60	---	.18	1,869	24.7
Silver	03I	14,556	2.13	(1.79)	.76	2,805	19.3
North Fork Entiat	03J	17,643	.79	(.74)	1.30	1,339	7.6
Tommy	03K	12,540	.37	(.28)	1.05	647	5.2
Roaring	03L	16,296	4.46	(4.09)	.20	2,745	16.8
Dinkleman	03M	7,630	4.92	(4.14)	0	1,348	17.7
Lower Mad	08A	17,995	7.33	---	.06	4,799	26.7
Middle Mad	08B	10,626	3.82	(3.49)	.75	1,776	16.7
Upper Mad	08C	16,820	1.82	---	.99	1,730	10.3
Headwaters Mad	08D	12,848	.12	---	1.80	894	7.0
Navarre Coulee	15B	11,944	2.45	---	0	9,957	83.3
Ribbon Mesa	15C	10,884	1.71	---	.3	6,263	57.8
Swakane - Spencer	15D	32,070	1.36	---	1.53	13,891	43.3
TOTAL		**323,262**					

[1]**Road Density** - Road density in miles of road per square mile of land within the Fish Production Unit (FPU). These values were calculated using the road database in GIS, which has not been updated to include closure/obliteration work completed in 1993 - 1995.

[2]**Road and Trail Acres Affected** - Acres within each FPU that lie within ¼ mile (0.25) from either side of a road or trail.

[3]**Revised Road Density** - These revised road densities reflect road closure/obliteration work completed during 1993 - 1995. During this period, numerous spur roads were closed or obliterated through implementation of a series of watershed restoration projects. These values are approximate and are only provided to demonstrate current progress in access management and were not used to calculate "acres affected by roads and trails." Some of the roads closed during this period were re-opened for fire suppression purposes in 1994; updated road condition surveys are needed to verify current status.

[4]**Percent Affected** - Simple percent of the total FPU affected by roads and trails, based on the above-mentioned corridor width.

Summary

1. Winter range for wildlife species has been reduced significantly by other uses and human disturbance. Human activities impact an individual animal's ability to survive and be a part of the population. Wintering areas are critical to maintaining viable populations of many species that have viability or distribution concerns.

2. Habitat with low human activity levels is important to large carnivores for reproductive purposes (bears, wolves and wolverines). Human activities in these areas impacts these species in summer.

3. High elevation habitat is important to species that use only high elevation areas. Human activities year round can effect these species since weather plays a significant role in their survival.

4. Private lands and activities associated it has significant affects on habitat availability. The effects may be due to loss of acres to another activity or by being adjacent to federal ownerships.

5. Low elevation habitats with poor site productivity that are cold due to aspect are not as important to wildlife species that have limited populations.

Projects

1. Activities in deer winter range will be limited to corridors for access to other areas from December 1 to April 15 (EW1 Standard Forest Plan). Implement this standard in each FPU, including: Lower Entiat, Lower Mid-Entiat, Mud Creek, Stormy/Potato Creek, Roaring, and Dinkleman.

2. Purchase lands that have significant value as winter range habitat. FPU's to apply this to are: Lower Entiat, Lower Mid-Entiat, Mud Creek, Stormy/Potato Creek, Roaring, Dinkleman.

3. Maintain or reduce road/trail densities to 1 mile per square mile or less to maintain habitat for sensitive, threatened and endangered species year round. FPU's to apply this to are: Upper Entiat, Headwaters Entiat, Silver, Tommy, Lake Creek, Cougar Creek, North Fork of Entiat, Upper Mad, and Headwaters Mad.

4. Maintain or reduce road and trail densities in spring and fall to 1 mile per square mile or less to maintain migration routes from winter range to summer range. FPU's to apply this to are: Upper Mid Entiat, Preston, Lower Mad, Middle Mad.

Appendix A-7

Entiat Analysis Area
Northern Bald Eagle

Introduction

Bald eagles are federally listed as threatened. Management guidelines for this species appear in the Wenatchee Forest Plan, draft Forest Conservation Plan, and Bald Eagle Recovery Plan.

Eagles are known to fish the Entiat River and scavenge deer within the Entiat watershed during the winter. No nest sites are currently present, but potential nest sites were identified. There is an undetermined number of acres of suitable nesting habitat and approximately 100,000 acres of feeding habitat. Potential territories were identified in the draft Wenatchee National Forest Bald Eagle Plan. No recovery sites were planned for this watershed. It is not known if there are active roost sites in the watershed.

Habitat Definition

Shrub-steppe, meadows, Douglas-fir series, marshes, rivers, riparian areas, streams, and lakes are used by eagles for feeding. Douglas-fir, ponderosa pine, grand fir, western hemlock, and silver fir series are used for nesting. Eagles need large trees for nesting and stands of large trees for roosting. Preferred prey is fish and ducks, but will use deer carrion as a winter food source.

Condition Trends

Stable or increasing populations Forest-wide. Habitat trend is unknown. Population will likely continue as in past ten years.

Historic Condition

Bald eagles were a common species in this area historically. There were hundreds along the Columbia River and there were probably several nests in the Entiat watershed. Anadromous fish runs, native fish populations, and migratory ducks were more abundant in the past, hence a larger food supply was available to the eagles. Nest and roost trees were available in good supply in old growth Douglas-fir and ponderosa pine stands.

Existing Condition

There are no nest sites in the Entiat drainage. Bald eagles are occasionally observed fishing along the River or feeding on deer carrion in the winter. No roost sites are known to exist in the Entiat watershed.

Most of the potential nest areas were burned during the Tyee Fire. There still may be some old, large trees present that have the potential of being used by eagles for nesting purposes.

Anadromous and native fish populations have declined due to fishing in the Ocean, Columbia River, and local streams. Additional environmental hazards for anadromous fish have limited their food availability as well. While migratory ducks inhabit the Entiat and Columbia River drainages, duck populations are considered to be low, compared to the past. There are protected areas along the Columbia River used by ducks for feeding and nesting, so ducks are available to eagles.

Fifty years ago, it was common for people to shoot eagles. This casued the bald eagle population to decline and conditioned eagles to avoid people. Eggshell thinning due to pesticide residue also contributed to their population's decline.

Summary of Historic and Existing Conditions

1. The population of bald eagles and their prey species is lower than it was historically. Populations in the west and on the Forest have increased during the last ten years.

2. Prey species for bald eagles have been impacted by both the Tyee Fire and other management activities (timber harvest, recreation, etc.). The availability of sufficient prey and nest sites is likely represent the most limiting factors that influence the recovery of the species.

Potential Improvement Projects

1. Improve habitat for fish and ducks.
2. Construct artificial nests in large trees to mitigate the loss of nesting habitat in the Tyee Fire area.
3. Reforest riparian areas to provide nesting habitat in the future.

Appendix A-8

Entiat Analysis Area
American Peregrine Falcon

Introduction
Peregrine falcons are federally listed as endangered. There are guidelines in the Wenatchee National Forest Plan and the USDI Peregrine Falcon Recovery Plan to direct management of this species.

Peregrine falcons have been observed in the Entiat watershed. There are no known nest sites. There are an unknown number of acres of potential nesting habitat and approximately 100,000 acres of feeding habitat. There are no plans to establish artificial nest sites to meet recovery goals in the watershed.

Habitat Definitions
Nests on large rocky cliffs. Feeds primarily on other birds near marshes, lakes, rivers, and open upland habitat.

Condition Trends
Stable or increasing populations Forest wide. Suitable habitat has increased over the short term (10-30 years) in this watershed. In 30-100 years habitat is expected to return to near historic levels.

Historic Condition
Peregrine falcons were a common species in this area historically. They were found along the Columbia River and possibly in the Entiat watershed. There is potential nesting habitat in this watershed.

Existing Condition
There are potential nest sites in the drainage. It is not known if there are existing nests, but it is suspected that no nesting is occuring.

A review of neotropical bird surveys showed that most of the bird species that peregrine falcons would feed on are available Forest wide. Populations of some prey species are declining and the overall result is less food availability.

It is not well understood how the peregrine falcon's prey species populations will react to the 1994 burn. In all likelihood, many species populations will decline and others will increase.

Summary of Historic and Existing Conditions
1. Peregrine falcons and their prey species populations have declined over time. Populations on the Forest have increased over the past five years.

2. Peregrine falcon prey species were effected by the 1994 fires. Factors benefitting the prey population trend are not well understood.

3. The availability of habitat and prey is not entirely known.

Projects
1. Inventory potentially-suitable nesting habitat.

2. Identify prey species and prey habitat used for food in this watershed so that trends in habitat and populations may be assessed.

3. Prepare a Province Plan so that the potential affects of projects can be determined, suitable habitat can be evaluated, and potential affects on peregrine falcons can be determined for NEPA projects.

Appendix A-9

Entiat Analysis Area
Gray Wolf

Introduction

Gray wolves are federally listed as endangered. There are guidelines in the Wenatchee Forest Plan and the draft Recovery Plan established to direct management of this species.

Wolf sightings have been recorded in this watershed for many years. There are no known den sites. There are about 235,000 acres of suitable habitat. Many of the suitable acres (about 50,000) are less likely to be used by wolves due to human habitation and activites.

Habitat Definitions

Dens are usually located in remote country with adequate sources of prey and water nearby. Typical prey species include deer, elk, mountain goats, bighorn sheep, and small mammals.

Condition Trends

Deer populations will likely decrease the first two years after the 1994 fires.Beyond this, they will increase until they return to current levels, which will occur in about ten years. It is possible that populations may increase for a time after that. Because wolf populations are so small, it is unlikely that changes in deer populations will affect wolf populations. Wolf populations are expected to increase in the next ten years.

Historic Condition

Gray wolves were a common species in this area historically. There were many along the Columbia River and there were likely a number of dens in the Entiat watershed.

Mule deer were the main prey and the deer winter range was much larger.

Wolves had a significant effect on deer populations and deer populations had significant effects on wolf populations.

Existing Condition

Since the early settlment of this watershed, wolves have been killed by humans to prevent damage to domestic livestock populations. In the last five years, trapping for predators that attack permitted livestock on allotments was halted by the Wenatchee National Forest. Within two years of terminating predator control, sightings of wolves increased significantly. It is unknown if a relationship exists between trapping restrictions and subsequent sightings, however, any reduction in wolf mortality in this area would result in increased wolf numbers.

Deer populations are as high or higher than they were historically. Therefore, food is present but may not be available.

Hunters shoot coyotes and may shoot wolves accidentally or intentionally. Educational programs on wolves have been occurring for about three years. It is hoped that this will benefit wolf recovery in this watershed.

Roads and human activities have increased significantly in the last 90 years. Wolves have learned to avoid areas inhabited by humans because of the high mortality potential in those locations. Road and trail densities in this drainage are much higher than recommended in the draft Gray Wolf Recovery Plan currently in progress.

Summary of Historic and Existing Conditions

1. Wolf populations are lower than they were historically. Populations in the Northwest and on the Wenatchee National Forest have increased in the last few years.

2. Human-induced mortality and activities affect wolf populations.

Projects

1. Reduce human activities in key areas potentially used by wolves. In winter, eliminate human activities on deer winter range. In spring and fall, reduce human activities in deer migration routes (which are also wolf travel routes). In summer, reduce human activities on summer range.

2. Implement Gray Wolf Recovery Plan.

3. Prepare a monitoring and inventory plan for wolves. Inventory and monitor wolf populations.

4. Inventory winter range areas that are heavily used by deer during winter months.

5. Purchase key pieces of deer winter range to reduce residential construction and the affects associated with human activities on deer and wolves.

6. Continue to present educational programs on wolves.

7. Manage habitat to maintain or increase deer populations.

8. Coordinate wolf management with range management in the Entiat drainage.

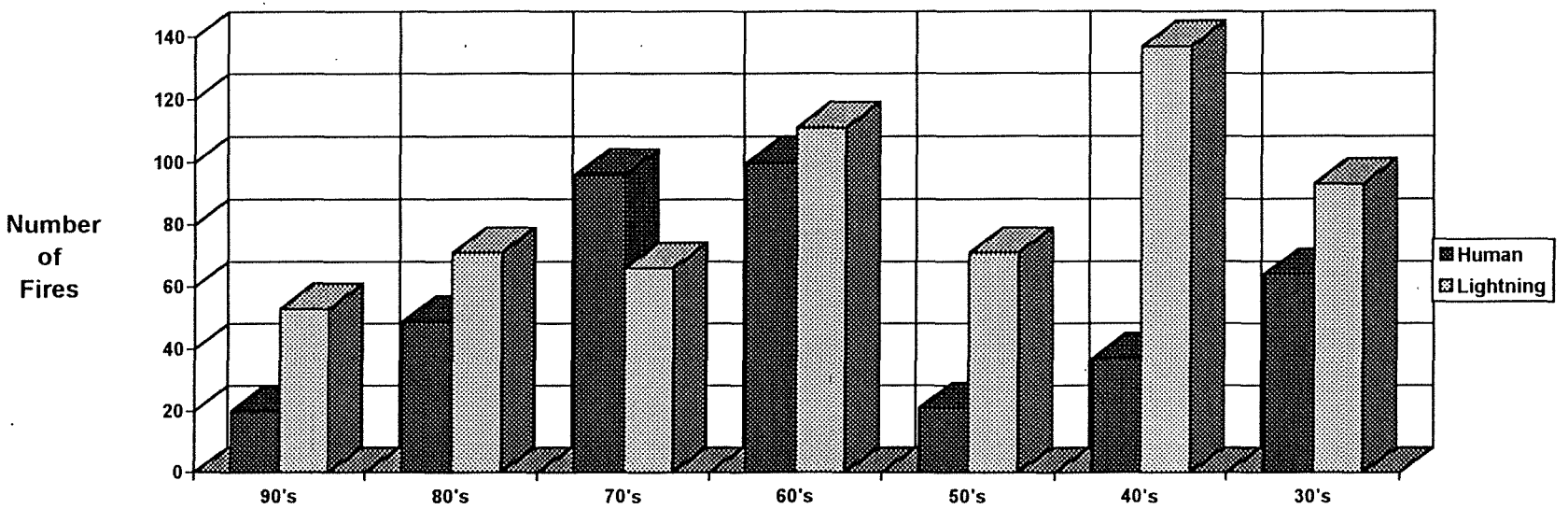
Appendix B
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Fire/Fuels

Page

B-1 (Figure) Entiat Watershed - Fires by Decade B.2

B-2 Vegetation Zones and Related Models B.3



Appendix B-1. **Entiat Watershed - Fires by Decade.**

Appendix B-2

Vegetation Zones and Related Fuel Models - Entiat Analysis Area

Watershed Vegetation Zones	Fuel Models	Vegetation Acres	Percent Total of Watershed
Shrub/Steppe	1,6	96,558	29.8
Dry-Open	2,8,9	77,079	23.9
Wet-Mix	9,10,11	121,923	37.8
Subalpine	10,12	21,002	6.5
Open Subalpine	10,2	3,329	1.0
Agricultural	None Assigned	1,918	.6
Snow-Water-Ice	None Assigned	1,277	.4
TOTAL		**323,086 Acres**	

Fuel Model Definitions and Descriptions

Fuel Models are a set of parameters that define fuel input to the fire spread model. In other words, a fuel model provides a list of numbers that describes the fuel in terms that the fire spread model can use.

FUEL MODEL 1 - Short grass (1 foot): Fire spread is governed by the fine, porous, and continuous herbaceous fuels that cured or are nearly cured. Fires are surface fires that move rapidly through cured grasses and associated materials. Very little shrub or timber is present; generally less than ⅓ of the area.

FUEL MODEL 2 - Timber (grass and understory): Fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition to the litter and dead stemwood from the open shrub or timber overstory, contribute to the fire intensity. Open shrub lands and pine stands that cover ⅓ to ⅔ of the area may generally fit this model. Such stands may include clumps of fuels that generate higher intensities and may produce firebrands.

FUEL MODEL 6 - Dormant brush, hardwood slash: Fires carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, greater than eight mi/h at mid-flame height. Fire will drop to the ground at low wind speed or at openings in the stand. The shrubs are older, but not as tall as shrub types of model 4 and do not contain as much fuel as found in model 4. A broad range of shrub conditions is covered by this model.

FUEL MODEL 8 - Closed timber litter: Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentrations that can flare up. Only under sever weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needled conifers or hardwoods which have "leafed out," support fire in the compact litter layer. Principally, these are needles, leaves, and occasionally twigs since little undergrowth is present in the stand. Representative conifer types are white pine, lodgepole pine, spruce, fir, and larch.

FUEL MODEL 9 - Hardwood litter: Fires run through the surface litter faster than model 8 and have longer flame heights. Closed stands of long-needled pine, such as ponderosa, are grouped in this model. Concentrations of dead-down woody material will contribute to possible "torching out" of tree, spotting, and crowning.

FUEL MODEL 10 - Timber (litter and understory): The fires burn in the surface and ground fuels with greater intensity than in the other timber litter models. Dead-down fuels include greater quantities of three-inch or larger limbwood, resulting from the overmaturity of natural events that create a large load of dead material on the forest floor.

FUEL MODEL 11 - Light logging slash: Fires are fairly active in the slash and herbaceous materials intermixed with slash. The spacing of the rather light fuel load, shading from overstory, or the aging of the fine fuels can contribute to limiting fire potential. Light, partial cuts or thinning operations in mixed conifer stands and hardwood stands are considered.

FUEL MODEL 12 - Medium logging slash: High intensity, rapidly-spreading fires which are capable of generating fire brands can occur. When a fire starts, it is generally sustained until a fuel break or change in fuels is encountered. The visual impression is dominated by slash and much of it is less than three inches in diameter.

Appendix C
to
WATERSHED ASSESSMENT
Historical Overview - Entiat Analysis Area

Entiat Valley History

DATE	EVENT	REFERENCE INDEX NO.
Dec. 14, 1872	Ribbon Cliff Earthquake.	1
1888	Fire - Mad River Gorge to Blue Creek Meadows.	2
1890	Massive overuse of sheep grazing. USDA photos of upper Entiat region show 13,000 sheep grazing. There are reports of eight bands of 2,000 sheep grazing in the Mad River and Entiat range areas.	4 & 16
1892	•C.A. Harris sawmill (Grays Mill) located below the present day Numeral Mountain at the mouth of the Entiat River. Logs were harvested upriver, along the River banks and driven down the Entiat River during high water. •C.A. Harris plants orchard two miles above mouth of Entiat River.	5 & 16 21
1894 **Oct. 27, 1894**	•Major flood. •Grazing reports - 1,000 cattle and 400 horses graze year round, between the town of Entiat and Stormy Creek. In the head of Entiat Valley, 13,000 sheep graze and in the foothills there were 150 hogs. •Irrigation ditch constructed for the 600-acre Entiat Improvement Co. Ranch. It was located above the present-day Naumes Orchard, four miles up the Entiat River, extending to the mouth of the River. Cattle ranged as far as Potato Creek. Corrals for summer grazing were located at Mud Creek. •C.A. Harris Mill washed out by flooding. •A.L. Rogers of Waterville files water rights on behalf of Entiat Improvement Company.	7 2 & 4 4 & 8 22
1898	•A dam/sawmill constructed one mile from the mouth of the Entiat River. •Reports show significant salmon and steelhead runs prior to 1898.	7 2
1902	Upwards of 60,000 sheep graze in the head of Mad River.	16
1904	•Gray constructs electric power plant at the mouth of the Entiat River. •Construction of Knapp sawmill at Mills Canyon. Logs were harvested upvalley. Mills Canyon originally named Knapp Canyon. •The last (sizable) chinook salmon run on the Entiat River. •Entiat District experiences heavy fire season.	8 3 & 8 2 25
1905 & 1906	Grays power plant experiences winter closures due to low water levels.	3
1906	Shift from cattle to apples hits the Valley. Orchard tracts begin to appear.	3
1908	•Sheep grazing allotments in Mad Lake area; included approximately 18,000 sheep •Forest Service Supervisor, A.H. Sylvester, states at least ten-year period of overgrazing has occurred in Baldy Mountain and Snowbrushy Creek areas.	4 4
1909	C.A. Harris' electric 2,000 horsepower plant constructed at present-day Keystone Bridge 1½ miles up the Entiat River. Puget Sound Power eventually buys plant and shuts it down. Power provided from Wenatchee.	3 & 8
July 31, 1910	•Signal/Tyee Peak Fire - 2,560 acres.	2

Entiat Valley History (continued)

DATE	EVENT	REFERENCE INDEX NO.
1912	•Forest Service records show two permittees for sheep grazing; about 7,300 sheep for a four-month season. H. Harder grazed Entiat Summit to the Mad Lake. George Hendricks grazed North Fork and upper Entiat. Both permittees operated until 1940 and 1950. •Kellogg Lumber Mill located three miles up the Entiat River operates until 1916. The River is dammed and logs are floated from up-valley logging areas.	4 5
1913	First recorded timber sale, located in the South Fork of Mud Creek.	9
1914 **August 31, 1914**	•Coleman Mill located at Crum Canyon •Burns Creek Fire - 600 acres.	14 2
1915 **Jan. 1, 1915** **July 29, 1915**	•Gordon Mill located up Johnson Creek - operated until 1920. •Severe winter 1915/1916. •Extreme conditions cause starvation of wildlife. •Entiat River planted with 310,000 trout from a Seattle hatchery.	8 1 8 (photo) 17
1916	•Mott Mill located at Mud Creek and later purchased by C.A. Harris. •Cannon logging camp located at mouth of Tyee Creek. Operated through 1918, and utilized horse skidding and chutes.	8 8
1917	•Period of drought through 1932. •Harris circular sawmill located at Mills Canyon, operated through 1919. Logs harvested from Mills Canyon and processed at 15 MBF per day. •Grays Mill located at Johnson Creek - Mill burned and not rebuilt.	18 5 8 & 14
1919	•Harris Mill moved from Mills Canyon location due to depeletion of logs. New location three miles up Mud Creek. Mill operated as a box factory until 1932, when it moved to Mad River location.	5 & 11
April 8, 1921	•Entire town of Entiat burns.	1
1922	Harris Mill at Mud Creek becomes a single-band mill with a 40 MBF per day capacity. Logging performed in the winter on snow. Logs decked to run in the summer.	5
Aug. 15, 1924	Summer rainstrom causes extensive flooding in Goman, Byrd and Ribbon Cliff Canyons. Electrical storm preceding heavy rains, responsible for largest number of forest fires ever reported (to date) on the Entiat District.	17
1925	**<u>Large Fires</u>** * Mad River Fire (between Windy and Young Creeks) - 1,500+ acres * Spectacle Butte Fire - 600 acres * Borealis Ridge Fire - 500 acres **<u>Fires in the 300-acre range, included</u>**: * Three Creeks * Lake Creek * Brennegan Creek * Gray Canyon * Mud Creek •Horse logging continued, but transportation to the Mill was by Mack trucks with hard rubber tires. Logging began to change with road construction, new equipment and transportation methods.	 12 & 24 12 & 24 5
1926	Potato Creek Allotment. Area included Potato and Stormy Creeks. One permit issued for 65 cattle and 6 horses.	4

Entiat Valley History (continued)

DATE	EVENT	REFERENCE INDEX NO.
1928 Aug. 28, 1928	•Harris Mill purchased first shovel loader. •Forest Service land acquisition in T24, 26 and 27N, R20E, which expands range in Mud Creek and Moe and Crum Canyons. •Coal Oil Fire - 600+ acres, caused from coal oiling irrigation canal.	5 4 17
1929 Aug. 1, 1929	•Extreme fire season. •Upper Entiat River planted with 160,000 rainbow trout.	1 17
1930	•Construction of fire lookouts and creation of CCC. •Entiat River survey shows that River is virtually devoid of salmon.	 2
1932	Harris Mill at Mud Creek moved to mouth of Mad River (Ardenvoir) due to low water caused by the drought period. The Mill is steam-powered with a capacity of 60 MBF per day.	5
1935	By this year, no dams remain on the Entiat River, although 19 irrigation diversions still exist.	5
1939	•Harris Company entered into voluntary cooperative sustained-yield agreement, which reduced ponderosa pine harvest while increasing minor species. •New inventions bring about discontinuation of horse skidding.	5 5
1940	Truckloads of salmon planted into the Entiat River for four consecutive years at several locations in Burns Creek vicinity.	8
1941	•Larch Lake Fire - 400 acres. •Introduction of contract loggers.	16 5
1946	Flood Control Act.	
1948 June 8, 1948	•Harris Mill at Ardenvoir converted from box shooks to commercial lumber. •Worst flood in Entiat Valley history. Extensive damage from Ardenvoir to mouth of River, which was caused by a spring rainstorm. Several bridges were lost or damaged.	5 1
1950	Coldest/snowiest year on record for 61 years. Coldest recorded day in history - February 1 at 24° F below zero.	10
1953	Harris mill installed horizontal resaw, which increased production capacity to 70 MBF per day.	5
1955	Harris Mill increased to year-round production, processing more timber per employee than any other mill in the area.	5
1956 July 13, 1956	•In 1956-57, Mud Creek area is relogged. Trees too small by 1917 standards were cut under U.S. Forest Service marking rules. •Flash flood covers Highway 97 with up to four feet of mud, water and debris.	5 1
1958 Aug. 26, 1958	•No. 1 hottest recorded year. •Potato Creek erosion control project covered 110-acre area. It resulted from the impacts of logging and grazing. •Entiat Fire 12,000 acres. Lightning caused.	10 2 & 11 1 & 12
1960	Potato Creek Allotment permit - 219 cattle AUM. Intensive three-year development study initiated.	4
June 29, 1961 Nov. 11, 1961	•Tenas George Fire - 3,750 acres. Equipment caused. •Rocky Reach Dam commences commercial operation.	12 & 23 1
1962	Forest Mountain Fire - 520 acres. Lightning caused.	12 & 23

Entiat Valley History (continued)

DATE	EVENT	REFERENCE INDEX NO.
1964	•Potato Creek Allotment improvements include six stock ponds and 25 springs. Study shows that the Allotment could support 159 AUM for a 4½-month season. •First steelhead planting in the Entiat River.	4 2
August 26, 1966	Hornet Creek Fire #143 - 1,520 acres. Lightning caused.	12 & 23
August 5, 1968	Harris Mill Fire #065 - 1,210 acres. Started at mill site and moved to private, National Forest, BLM and county lands.	12 & 23
1970 **July 7, 1970** **August 23, 1970**	•Department of Game permitted cattle to graze in Mud Creek (Stepping C Ranch). Lands sold to City of Seattle in 1974. Through a tripartite exchange, lands will become National Forest. •Mills Canyon fire - 933 acres, human caused. •Lightning storms cause major fires covering over 122,000 acres on Entiat and Chelan Districts. * Gold Ridge Fire - 16,100 acres * Entiat/Slide Ridge Fire - 49,200 acres •Fires involve 25 percent of the Entiat watershed.	4 12 & 23 1 2
1971 **April 1971** **Nov. 18, 1971**	•No. 1 record snowfall. •Agreement between Department of Game, Entiat Valley Stockman's Association and Forest Service curtails grazing in Johnson Creek, Oklahoma Gulch and Entiat Breaks. •Corps of Engineers remove ten miles of river debris. •First helicopter fire salvage sale contract on Wenatchee National Forest and first in Washington State history.	10 4 2 1
1972	•Preston Creek slide area debris removal. •Entiat River channel changed below Fox Creek to protect road. •Pack River purchases Harris' Ardenvoir Mill. •Ardenvoir Mill begins to rely on logs from outside the Entiat basin to continue production levels.	2 2 11 5
March 1972	Record high temps with 150 percent normal snowpack, which increased flow rates; McCrea Creek slope failure and debris-dam-break flood.	2
June 1972	Record 1971-1972 snowpack combined with heavy rainfall results in flooding and streambank erosion (325 acres of agricultural land is damaged by floodwaters).	2
June 10, 1972	•Preston Creek slides and floods; four people killed; mud & debris avalanches also occur in Brennegan, McCrea & Fox Creeks	1 & 2
1973 **August 23, 1973**	•Drought forces cattle off federal rangelands early. •Northwest experiences worst drought in history.	1 1
January 15, 1974 **January 16, 1974** **Spring 1974**	•Entiat River rises 1.5 feet as a result of three inches of rain in three days. •River ice jams blasted in Entiat River. Entiat River freezes from the bottom upward (termed "anchor ice"). •Above-average spring runoff causes severe bank erosion over entire basin.	1 1 2
Dec. 12, 1975	Ardenvoir Mill Fire, 150 mill workers affected.	1
1976 **July 24, 1976** **Oct. 24, 1976**	•Ardenvoir Mill rebuilt. •Crum Canyon Fire #050 - 9,000 acres. •Entiat River planted with 570,000 salmon eggs. •Construction of spawning channel below Fox Creek.	11 12 1 1
June 13, 1977	Crum Canyon Flood. Second storm occurs on June 25.	1

Entiat Valley History (continued)

DATE	EVENT	REFERENCE INDEX NO.
1979	Ardenvoir Mill closes.	11
1983	•No. 1 wettest recorded year (from 1952). •Establishment of Mosquito Ridge Sheep Allotment, which covers an 11,600-acre area.	10 6
1984	Permit for 2,000 to 2,500 sheep on Mosquito Ridge Sheep Allotment from May 15 through August 31.	4
1987	No. 1 record year of consecutive days without precipitation - a total of 103 days (July 20 through October 30, 1987).	10
Sept. 4, 1988	Dinkleman Fire - 53,000 acres. Human-caused fire.	1 & 12
1989 **Jan. 17, 1989** **July, 1989** **Aug. 19, 1989**	•Salvage logging operations allowed for only five percent ground disturbance. All logging either helicopter or on snow. •Hurricane-force winds cause massive blowdown in Lake Creek basin, and Young, Billy and Cougar Creeks. •Roaring Creek flood •Dinkleman flood; Thousands of small chinook salmon and 10,000-50,000 non-game fish perish as a result	1 & 15 1 1 1
July 24, 1990	Dick Mesa Fire #110 - 1,151 acres. Lightning caused.	12
Jan. 10, 1991	Ice dam in Entiat blasted. Largest build-up in 50 years.	1
May, 1993	City of Seattle & USFS close riparian pastures in Mud & Potato Creeks	6
1994 **July 24, 1994** **October 1994**	•City of Seattle closes Mud Creek lands to range due to overuse. •Tyee Fire Complex #047 - 140,196 acres. Lightning caused. Total Entiat Dist. acres 85,968, accounts for 61% of fire area. •Fire involved 33% of Entiat watershed. •No. 1 wettest recorded month.	6 12 12 10
November 1995	City of Seattle-USFS land trade; City holdings in Entiat area traded for USFS lands in Cedar River watershed	

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19. An Historical Overview of the WNF, WA
20. WNF Supervisor's Office historical files
21. Thesis of Lois Morrell Harmon
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23. Wenatchee National Forest Land and Resource Management Plan (1990)
24. Historical microfiche files
25. Wenatchee Republic Newspaper

Significant Dry, Wet and Fire Activity Years in the Entiat Analysis Area

(based on unpublished tree ring data: Richard Schellhaas, U.S. Forest Sciences Laboratory)

Dry	Wet	Fire
	1609	
	1616-1617	
1657		
1661		
		1682
1691		1691 •
1695		
		1706
1708		
1710		
	1716	
		1717
1721		1721 •
		1733
		1735
1739		
		1751
		1756
		1759
1760		
	1761-1762	
		1768
		1781
1783-1784		
1787		
		1791
1794-1795-1796-1797-1798		
		1799
		1812
1817		
	1820	
		1822
1823		

Dry	Wet	Fire
		1828
1834		1834 •
1839-1840		
	1841-1842	1841 •
		1844
	1845-1846	
1848-1849		
		1854
1856		
1862		
		1863
	1868	
		1870
1871		
1874-1875		
		1886
	1888	
1889		
1894-1895		1895 •
	1908	
1920		
	1921	
1926		
	1928	
1929-1930-1931		
	1938	
1944		
	1960	
1973		
1977		
1979		
	1983-1984	

Appendix D
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WATERSHED ASSESSMENT
Entiat Analysis Area

Scenery

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Appendix D-1

Desired Scenic Condition and Character
Entiat Analysis Area
Steps 1/2

Issues and Desired Scenic Condition and Character

1. The Entiat watershed area is bisected by the main scenic Entiat Valley Road #51, from the mouth of the drainage and ending at the Cottonwood trailhead, which provides access to the Glacier Peak Wilderness. Two major recreation roads, French Corral #5800 and Road #5900 provide viewing and destination recreation to the forested landscapes of adjacent watersheds. There are several forest roads that provide access to dispersed recreation sites, scenic vista viewpoints and offer loop opportunities for short scenic drives. Some of these roads have a highly-altered foreground and middleground due to past forest management practices and detract from the high quality sensory experience.

   Over time, the scenic quality of Entiat Valley Road #51 will continue to improve as a reflection of the public desire for quality scenic landscapes. People expect to see a naturally-appearing landscape when travelling through the area.

   The Entiat watershed will continue to provide a diversity of quality, year-round recreation opportunities and experiences. Rehabilitate altered forest road sides and promote protection of scenic resources through Forest Plan allocations, where a higher level of protection may be granted.

2. The Tyee Fire of 1994 consumed the area from Crum Canyon to Preston Creek, on the lower end of the Entiat watershed. A large portion of the foreground is on private and other lands. The middleground view is dominated by USDA Forest Service lands. It is assumed that private lands will be heavily modified through logging activities, thus reducing the availability of natural-appearing forests. The private lands may be salvaged logged in a manner that drastically affects scenic quality. Demand on public lands for natural-appearing landscapes will increase.

   Maintain a mosaic composition of high, moderate and low burn intensity areas for interest and visual variety in the short term and transition to the desired long-term scenery. The landscape character of the natural effects of wild fires are interesting and awesome, even though the landscape is drastically changed. The effects of logging and clearcutting activities are negative scenic impacts on the landscape condition of the burned area.

3. The Tyee Fire falls within a Scenic Travel 1 (ST-1) allocation along the foreground of Entiat Valley Road #51. The General Forest allocation (GF) applies to the dispersed use areas, side roads and middleground of the main Road #51. The Key Wildlife allocation (EW-1) also applies in the lower end of the Valley Road foreground and middleground area. The scenic quality objectives vary from Retention to Modification objectives.

   The critical concern is the middleground views from Entiat Valley Road #51 which are not scenically protected from the current Forest Plan direction. Scenery resources that are visible from Entiat Valley Road #51 need to be protected from alteration.

4. Trails 1409, 1410, 1411, 1413, 1415, 1416, 1418, 1448 and 1454 travel through a variety of scenic conditions and through a portion of heavily-burned forest. Portions of these trails have been degraded due to fire suppression activities of building cat fire lines on or adjacent to the trails. The safety of trail

users along roadsides must be assessed because of burned, dead or dying trees near trailside zones and roadside zones.

The foreground of trails should be managed to be natural-appearing and provide a safe recreation experience.

Appendix D-2

SCENERY MODULE
Watershed Assessment
Entiat Analysis Area

I. INTRODUCTION

Scenic quality is an important amenity in our lives. People's interests and expectations regarding ecosystems help establish desired aesthetic conditions for the varied landscapes. Scenery is a combination of biophysical elements and cultural elements and may be visually described in terms of form, line, color, and texture. The basic premise to emphasize is that on public lands, people expect natural-appearing scenery to visually dominate cultural or human alterations, especially in forested landscape settings. "The methodology to conduct scenic assessment is based on a rational and artistic process, and is not just a romantic or emotional process." USDA, Scenery Assessment, Pg.7. Scenic assessment consists of inventorying scenic quality, using two primary indicators - landscape character and scenic condition.

The management direction for the Scenic Resource of viewsheds within the Entiat watershed area will be discussed as it relates to the Wenatchee National Forest Land and Resource Management Plan 1990, (WFP), the Northwest Forest Plan and the Entiat Valley Corridor Viewshed Plan. Additional information and descriptions regarding Visual Quality Objectives (VQO'S) may be found in the Forest Service Scenery Management System (USDA Forest Service 1993 [in draft]), and the Visual Management System (USDA Forest Service 1974); National Forest Landscape Management handbooks.

The following definitions will apply throughout the remainder of this document:

Scenic Condition: changes in the landscape that are caused by human activity.

Scenic Character: particular attributes, qualities, and traits of a landscape that give it an image and make it identifiable or unique.

The Entiat Watershed Analysis, Version 1.0, contains the complete scenery module write-up. The additional information in Version 2.0 will address the Columbia Breaks tributaries, which span from the Birch Mountain area north to Navarre Coulee to Forest Mountain and easterly from the Columbia River.

Wenatchee National Forest Land and Resource Management Plan, Version 1.0

According to the Wenatchee National Forest Land and Resource Management Plan, the Entiat watershed area has one main scenic corridor, which is allocated to Scenic Travel 1 (ST-1); Scenic Travel 2 (ST-2); General Forest (GF); and Key Wildlife (EW-1) designations. These designations imply that management activities must meet the Visual Quality Objectives (VQOs) of Retention, Partial Retention, or Modification. In areas designated Retention, all foreground landscapes shall have the visitor perception of natural appearing (WNFP IV-205). In areas designated Partial Retention, the visitor will perceive a natural-appearing to slightly-altered landscape viewed in the foreground and middleground areas (WNFP IV-215).

The prescription ST-1 applies to foreground areas of Entiat Valley Road #51. Foreground is defined as views from 0 to ½ mile.

The prescription ST-2 applies to middleground areas of Road #51. Middleground is defined as views from ½ mile to 5 miles.

Wenatchee National Forest Land and Resource Management Plan Version 2.0

The Columbia Breaks Version 2.0 watershed area has three main travel routes which are rated as Level 1 sensitivity viewsheds. These are U.S. Highway 97 and 97A (U.S. Highway 2), and Highway 971 (Navarre Coulee). The following land allocations and established Visual Quality Objectives apply to these travel routes:

Scenic Travel 2 (ST-2)	Partial Retention VQO
Riparian Zones (EW-2)	Retention to Modification VQO
Old Growth (OG-1)	Retention VQO
General Forest (GF)	Modification VQO
Key Deer and Elk Habitat (EW-1)	Modification VQO

In areas designated to General Forest and Key Deer and Elk Habitat, Modification VQO, human activities would be visually evident, but should blend into the landscape by utilizing naturally-established form, line, color, and texture from the natural landscape. Modification areas would have Low Scenic Integrity in General Forest. In areas of Key Deer and Elk Habitat, Scenic Integrity should range from High to Low.

Northwest Forest Plan, Entiat Watershed area Version 1.0

The Wenatchee National Forest Land and Resource Management Plan has designated Visual Quality Objectives (VQO) and Recreation setting objectives. The Northwest Forest Plan is then overlaid to determine appropriate VQO'S. The following apply to the Entiat watershed:

Matrix	Range from Retention to Modification VQO
Managed LSR:	Retention to Partial Retention VQO
Administratively Withdrawn	Same as WI-1, Preservation VQO

Northwest Forest Plan, Columbia Breaks area Version 2.0

Matrix	Range from Retention to Modification VQO

II. HISTORIC SCENIC CONDITION AND CHARACTER, Versions 1.0 and 2.0

Landscapes have definable landscape character attributes that can be described at a variety of scales. The Entiat watershed level is the larger scale of context for describing historic landscape character. The watershed will be divided further in the "Special Places" narrative, to describe the sense of place for the Entiat watershed and Columbia Breaks area.

Entiat Watershed, Version 1.0

The landscape character is typical of the Northeast Cascades character type. The parallel mountain forms have approximately uniform crest elevations. Rock forms are common, especially on the ridge tops and steep upper slopes where jagged rocky peaks occur and glacier-carved outcrops abound. (USDA, Landscape Character Types, pg 45, 1982). The characteristic landscape pattern of the Entiat watershed is influenced by the physical features of geology and climate. The most outstanding physical geographical features of the Entiat watershed are the naturally-established elements of land form. The land form structure of glaciated peaks is outstanding.

In terms of assessing scenic quality, the vegetation patterns are the elements that change the most. Color and texture would be mosaics dominating the landscape patterns, while changing vegetation patterns would be observed throughout each season. The role of natural fire had an effect on the composition of vegetation patterns and added to the variety of form and color. The forms that would have been most common in the historic landscape would be proportional in scale to the naturally-established landscape and would likely be seen as irregular openings resulting from fires and meadows maintained through indigenous burning.

Overall, the landscape of the Entiat watershed area would have been different in visual appearance in terms of the natural characteristic landscape. The primary difference is that development of human settlement patterns would not have occurred along the lower half of the Entiat Valley, which now has a rural feeling in landscape character. Logging activities would not have occurred at the rate and scale of the 20th century, which have altered the naturally-established vegetated landscape character in some places.

Columbia Breaks, Version 2.0

The most outstanding physical geographical features of the Columbia Breaks area are the naturally-established elements of the steep dissected slopes and rocky outcrops along the Columbia River. The landform is steep with dissected tributaries facing the Columbia River basin. Although the Columbia River is not directly located within the watershed boundary, the direct influence is of significant importance. The Columbia River is adjacent to and parallels the Columbia Breaks country. Previous to development, the Columbia River was a free-flowing meandering river which was not as wide or "lake like" as it is today.

Historic landscape character of the Columbia Breaks area previous to the 19th century (or development of the transportation system) probably remained fairly constant. The changes most influenced were vegetation and cultural landscape patterns of the early Native Americans that lived in the area. The landscape of the Columbia Breaks tributaries would have been considerably different in visual appearance, in terms of the natural characteristic landscape. As the highways, railroad, and Rocky Reach Dam were developed, the flow of the Columbia River was altered. Human settlement patterns occurred along the Columbia River and human intervention began to interrupt fire regime patterns and brought the consequential change in vegetation compositions and patterns. The area appears natural. The Columbia Breaks tributaries show evidence of frequent natural fires throughout the area.

III. CURRENT SCENIC CONDITION AND CHARACTER, Versions 1.0 and 2.0

There are a variety of viewing opportunities within the Entiat watershed area, offering the forest user a range of visual experiences from sequential enclosed views of rocky canyons to more open vista views of the surrounding landscape. The Entiat watershed area has one main linear viewshed.

The vegetation is characterized by a wide variety of communities and species. Vegetation patterns vary throughout the watershed area. Generally, the area is dominated by true firs and hemlock at the higher

elevations and pine as elevation drops. The climatic species are primarily ponderosa pine and Douglas-fir on the south slopes. Cedar, spruce, subalpine fir and Pacific silver fir occur at higher elevations and on north slopes. Riparian vegetation varies with elevation and climatic conditions.

The vegetation species and spatial distribution of plant communities that have been affected by or resulted from fire suppression activities are evident to visitors; however, they are not widely understood to be the result of human intervention in fire regimes. These effects (different vegetation communities and understory vegetation) are relatively subtle from a visual standpoint and not strongly linked with the more common perception regarding fire (e.g., such as black and silver snags, brown needles and black-charred trunks). For the purpose of analysis, subsequent references to the "effects of fire" refer to the obvious visual evidence that occurs as a direct result of fire rather than the subtle effects of different species of vegetation and spatial distribution of plant communities that are often in advanced succession. The assumption follows that, in general, visitors are not accustomed to seeing fire or the effects of fire, along roads, trails, and recreation sites. (SFCR White Paper, Newberry National Volcanic Monument Plan, Fall 1994).

Scenic condition is the amount of human-caused deviation in form, line, color, and texture of a landscape. Scenic integrity serves as a frame of reference for measuring scenic integrity levels based upon the valued attributes of the "EXISTING" landscape character "BEING VIEWED." The degrees of integrity vary from High to Very Low.

Scenic Integrity Descriptions

Scenic Integrity	Condition
Very High	Unaltered
High	Appears Unaltered
Moderate	Slightly Altered
Low	Moderately Altered
Very Low	Heavily Altered

The Entiat watershed area (Version 1.0) has been graphically mapped as either natural appearing or altered, based on vegetation characteristics. Overall, the Entiat Valley Road #51 corridor is altered in appearance along the lower end of the Valley floor and is natural appearing at the upper end of the Valley in the foreground and middleground. Refer to 1:24,000 maps located at the Wenatchee Supervisor's Office for the Entiat watershed Scenic Integrity (condition) locations. The permanent elements of power lines and highway corridors are fixed and cannot be significantly changed. Settlement patterns are also fixed elements. In some cases, measures may be taken to help blend these facilities into natural landscapes so they become more subordinant to the landscape.

The Entiat watershed has been analyzed for scenic variety. Scenic attractiveness classifications are:

Class A - Distinctive areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide unusual, unique, or outstanding scenic quality.

Class B - Typical areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide ordinary or common scenic quality.

Class C - Indistinctive areas where landform, vegetation patterns, water characteristics, and cultural land use have low scenic quality.

The Entiat watershed, for the Version 1.0 analysis, has been mapped for scenic variety. **Class A** landscape types are distinctive to the area. An example of the **Class A** type is the Entiat River corridor and the upper Mad River basin. **Class B** landscapes are common, such as the lower end of the Entiat Valley's ridge lines.

Columbia Breaks Version 2.0

Viewing opportunities within the major highway viewshed area, the Columbia Breaks, and Columbia River are limited. The landscape being viewed from the major highway corridors is seen as middleground, which acts as a backdrop landscape setting. Vegetation along the Columbia River basin is limited to grasses, shrubs, and some conifers, with cultured orchards along highways.

The Columbia Breaks watershed may be stratified into travel routes and viewsheds to determine where the established Visual Quality Objectives apply in relation to land allocations. There are three main travel routes: U.S. Highway 97; 97A (U.S.Highway 2); and Highway 971 (Navarre Coulee), which are rated as Level 1 sensitivity viewsheds. There are four secondary travel routes and viewsheds: Birch Mountain Road 2413; Swakane Road 252; Chumstick Road 2924 (Rattlesnake Springs to Mills Canyon); and Johnson Creek Road 2729. In addition to the travel routes, dispersed recreational activities also occur along the Columbia Breaks area, such as driving for pleasure to Rattlesnake Springs, Dick Mesa, Oklahoma Gulch, Goman Peak and other high bluff areas overlooking the Columbia River basin and Douglas County lands.

The Columbia Breaks of the watershed area are significant as a scenic backdrop setting from U.S. Highway 97 and 97A (U.S. Highway 2) and Highway 971 and for the rural communitites and summer homes along the Columbia River. The backdrop is steep dissected slopes with a variety of natural-appearing vegetative patterns that range from sparse to moderately-dense coniferous forests throughout. The tributaries have high-density patterns. U.S. Highway 97 and Highway 971 are segments of the Cascade Loop Tour, which has international appeal. A future destination area is the Columbia Breaks Interpretive Center located in Entiat, which will focus on the setting of the Columbia Breaks country.

Presently all the main travel routes mentioned above, which view into the Wenatchee Forest lands, are designated to EW-1 Modification VQO. These areas, which are viewed from these main travel routes, would require higher scenic quality objectives due to the importance of scenic travel. Future plans in the EW-1 areas are recommended, in order to pursue the scenic quality objective of Retention foreground and Partial Retention middleground. In most cases in the past, maintaining High scenic quality was compatible with the Key Deer and Elk Habitat (EW-1) and has similar landscape character type in the forest.

Maintaining higher scenic quality than Modification is recommended to the other secondary travel routes along the foreground, similar to Johnson Creek Road 2729. Other viewsheds not mentioned in the Version 1.0 analysis include: French Corral to Maverick Saddle, Shady Pass Road, Mad Creek/ Potato Creek Road, Roaring Creek, North Fork Entiat Road, Tyee Road to the lookout, Tommy Creek Road, and Road 8410 which traverses over to Baldy mountain. These travel corridors are important to maintaining a Partial Retention VQO along the foreground. Generally, the altered landscape is located in the middleground of U.S. Highway 97 and is seen as middleground and foreground views from secondary travel routes.

The spatial arrangement of dense to moderately-dense vegetation along the tributaries of the Columbia Breaks provides contrasting positive interest and a variety of forest compositions throughout. Color and texture of grasses and scattered shrubs with open to mosaic vegetative patterns change throughout the seasons. A variable, open to dense vegetation pattern provides contrasting textural patterns in the valley floor and along the riparian zone. Distant views of moderately-dense to dense vegetation provide a rich variety in a rather scattered open, grassy hillside. The secondary routes provide a variety of composition, consisting of altered to natural-appearing forested settings of open to dense mosaic landscapes with a variety of dense vegetation. This combines to provide interest and comfort and relief from the hot sun. Shade in the lower Entiat corridor and the Columbia Breaks is sought to enhance recreational experiences. The current character of the lower portion of the Columbia Breaks tributaries along the Columbia River and Highway 971 has changed from a mosaic, forested setting to an area dominated by the mosaic patterns as evidence of wildfire.

The fire-intensity patterns range from low to high, viewed in both foreground and middleground from the highway.

The major water body is the Columbia River. The River is peaceful, sinuous, and almost "lake like." It is a dominant feature in the landscape. Many dissected, low-flowing tributaries enter the Columbia River.

The entire Columbia Breaks area is classified as Variety Class B, common to the characteristic landscape.

IV. DESIRED SCENIC CONDITION, Version 1.0

Increase positive elements and minimize negative impacts. Provide a forested, green setting that appears natural. Blend human-caused alterations of the landscape with existing character so landscape appears natural. Rehabilitate visually-impacted areas, as identified through the EVG mapping.

V. DESIRED SCENIC CHARACTER (as related to vegetation) **Versions 1.0 and 2.0**

The desired landscape character is to promote a sustainable landscape character specific to each ecotype of the forest. All naturally-established existing landscape patterns throughout the forest are desired to be maintained with changes that will not degrade the existing character. Areas where unnatural landscape character exists as a result of past management practices can be improved through rehabilitation and enhancement. This will promote landscape character that is scenically and ecologically attractive. Identified areas of the forest are mapped as natural-appearing and altered scenic integrity (conditions). Where the natural-appearing landscape occurs, the landscape character and integrity (condition) goals are to maintain them for scenic quality. These landscapes are natural-appearing and scenically attractive, with a variety of form, line, color, and texture. Enhancement of these lands is possible through a decrease in stand structures and composition by a reduction of the number of trees in a variety of scales, to blend with the existing landscape character. Areas identified as altered integrity are locations where the character of the landscape is not scenically attractive. A rehabilitation strategy to promote a sustainable landscape character and scenically-attractive landscape is the goal. Where large trees exist, maintain them with other positive vegetative patterns that exist throughout the area. The goal will be to maintain the naturalness of the area and reduce contrast and negative elements while a new landscape character emerges. An example of this is leaving a variety of existing vegetative islands and retaining most of the scattered large trees through an area that is being rehabilitated, instead of total vegetation removal. The vegetation that is left will provide the linkage, patterns, structures, and scenic continuity while a new forest emerges.

The desired landscape character is to maintain all naturally-established landscape patterns and a variety of ecosystem management options by zones. (See "VI. Ecosystem Management Options by Zones for Scenic Resource" chart). To promote high quality scenery, strive for a diverse composition of all plants with variety of all age classes that are characteristic to the zone. Where existing large trees are present, maintain them as the future desired landscape character is created over time. Promote understory vegetation that is compatible with the ecosystems of the specific zone. Maintain natural-appearing openings.

An example of a broad description of desired character by climax zone appears below. A more detailed description, including age classes, will be described at the next level--NEPA. These descriptions will include elements necessary, in order to maintain mature character, size, shape, and location of different pattern elements, including natural-appearing openings. The goal is to create and maintain scenic diversity in natural-appearing patterns and the utilization of species listed in the following chart under each disturbance option. A suggested character description for each climax zone follows.

> **Grand fir zone:** Promote variety in composition of species. Grow hardwoods and shrubs for color. Encourage growth of Douglas-fir intermixed with grand fir and western larch on north slopes, quaking aspen in wet areas. Where ponderosa pine grows, maintain a variety of stand structures including park-like and multiple stories.

Douglas-fir zone: Promote and provide Douglas-fir stands intermixed with ponderosa pine. Maintain a variety of stand structures, including park-like and multiple stories in both ponderosa pine and Douglas-fir. To enhance fall color, encourage growth of western larch where possible.

Ponderosa pine zone: Provide a variety of stand structures including park-like areas with large-diameter yellow bark for viewing and multiple stories for texture. Encourage growth of Douglas-fir in moist microsites. Encourage park-like stands and multiple stories of Douglas-fir.

Subalpine fir zone: Provide subalpine fir and intermix with western larch for increased fall color. Maintain park land meadows for rich variety and promote Englemann spruce in wet areas.

Western hemlock zone: Provide western hemlock and add variety through increased growth of Douglas-fir, western white pine, western red cedar and noble fir. Enhance fall color with western larch.

Mountain hemlock zone: Promote mountain hemlock intermixed with subalpine fir, white bark pine, and subalpine larch for variety.

Pacific silver fir zone: Promote Pacific silver fir and encourage growth of Douglas-fir and all true firs for variety. Increase fall color with western larch.

Subalpine larch zone: Promote growth of subalpine larch and intermix with subalpine fir and Englemann spruce for variety. Maintain park land and meadows of alpine forbs and shrubs for richness in species composition.

Whitebark pine zone: Provide whitebark pine with variety of subalpine fir and meadows. Enrich area with mosaic patterns of lodgepole pine, ponderosa pine and Douglas-fir.

Riparian zones: Provide a diversity of conifers and deciduous trees and shrubs with varying structure, spatial pattern and mosaic of multiple-story composition. (See chart on following page for zones and elevations for specific areas).

VI. ECOSYSTEM MANAGEMENT OPTIONS BY ZONES FOR SCENIC RESOURCE

UNDISTURBED CLIMAX ZONE	OPTION WITH DISTURBANCE 1	OPTION WITH DISTURBANCE 2	OPTION WITH DISTURBANCE (micro site)	RIPARIAN ZONE
Grand fir, Dry forest type, Mesic forest type	Douglas-fir	Ponderosa pine especially on south facing slopes, low elevations and ridge tops	Western larch on north slopes, Western red cedar where wet and high rainfall, Quaking aspen, riparian, drier areas	Vine maple, Red-osier dogwood, Willows, Alders, Black cottonwood, Aspen
Douglas-fir, Dry forest type, Mesic forest type	Ponderosa pine	Lodgepole pine	Western larch in moist areas, Englemann spruce in higher elevations	Big leaf maple, Aspen, River birch, Bitter cherry, Willows, Service berry, Elder berry, Sumac
Ponderosa pine, Dry forest type	Grasses and shrubs	Juniper	Douglas-fir in more moist sites. Lodgepole pine in frosty sites.	Same as Douglas-fir zone
Oregon white oak, Dry forest type	Grasses and shrubs	Douglas-fir	Ponderosa pine	Same as Douglas-fir zone
Subalpine fir, Wet forest type	Lodgepole pine	Englemann spruce	Western larch, Western white pine, Douglas-fir, meadows	Sitka alder, Mountain maple, False azalea, Vine maple, Park land and meadows
Western hemlock, Wet forest type	Douglas-fir	White pine	Western white pine, Western larch, Western red cedar	Sitka alder, Mountain maple, False azalea, Vine maple, Devils club
Mountain hemlock, Wet forest type	Subalpine fir	Lodgepole pine	Whitebark pine, Subalpine larch, meadows	False azalea, Heather, Huckleberry, Park lands and meadows
Pacific silver fir, Wet forest type	Douglas-fir	Western hemlock Noble fir	Noble fir,Subalpine fir, Western white pine, Western larch, Western red cedar , Alaskan yellow cedar	False azalea, Heather, Huckleberry, Devils club, Vine maple
Subalpine larch, Wet forest type	Alpine forbs and shrubs	Bare soil	Subalpine fir, Englemann spruce	Huckleberry, sedges, grasses, Park land, meadows
Whitebark pine, Wet forest type	Lodgepole pine	Subalpine fir	Subalpine fir, alpine grasses	Huckleberry, sedges, grasses, Park land
Park land and Subalpine meadow, Non forest	Subalpine meadows	Park land	Park land and meadows	Meadows
Riparian	Low Elevation, Rainfall 10 -40 , Red-osier dogwood, Willow, River birch, Big leaf maple, Ponderosa pine, Douglas-fir	Moderate Elevation, Rainfall 40 -60 , Red-osier dogwood, Willow, Aspen, Douglas-fir, Grand fir, Vine maple	High Elevation, Rainfall 60 +, Sitka alder, Vine maple, Western red cedar, Western hemlock, Englemann spruce, Alaskan yellow cedar, False azalea, Devils club	N/A (WNF Table developed by Henry Maekawa, Barbara Jackson, Monte Bickford, Terry Lillybridge & Mils Henstrom, 1994).

VII. CURRENT SCENIC CHARACTER IN BURNED AREAS - 1994, Version 1.0

The fire boundary is located from Crum Canyon to Preston Creek and nestled among ridge tops and within rolling sloping drainages of the Entiat watershed. It is seen as foreground and middleground from the main travel route of Road #51 and from several secondary forest recreation roads.

The burn has created a drastic, sudden change to the scenic character and condition of the area. The scenic character of the landscape, within the burned area, will be broken into four categories for description; high, moderate, low intensity or unburned. Each category has unique visual attributes associated with the intensity of the burn.

Generally, the greatest change to the landscape is the loss of dominating forested green textural patterns. Now, the new characteristic that dominates pattern is the uniform line seen from tree boles and in some cases from roads, as contrasting line and color. Previous to the fire, the existing roads and human-caused activities and facilities blended into the forested green landscape. Other dominating elements are the black uniform areas and facilities and homes that were burned or that no longer have screening.

High Intensity Burn - From foreground view, the dominating element is the black lines of tree boles. In many cases, the line is very strong because of the high number of trees. From a distance, the landscape appears uniform with no textural patterns resulting from needles, branching boughs and tree structure. The dominating color is black and you may see many black tree boles. High intensity burned areas have the elements of color and line.

Moderate Intensity Burn - The landscape is uniform with brown needles in both foreground and middleground. In foreground, the color and line are not as strong as the high intensity landscape because horizontal branching is still present and the shape and structure of trees create texture in the landscape. The character of the landscape will change with time, as trees die from the effects of the burn. Thirty percent are estimated to live and maintain the mosaic landscape. The rest of the landscape will appear uniform with no textural patterns. A line of black tree boles will stand out. Moderate intensity burned areas have the elements of color, line, and texture.

Low Intensity Burn - In foreground, the landscape is the most diverse with mosaic patterns of live green trees intermixed with swirls of brown. The green patterns give the impression of a forested landscape that is alive and brings the positive elements of landscape upon landform in the spectrum of all elements, form, line, color, and texture. From a distance, textural patterns and the green islands dominate; from closer views, the green trees bring life to the area.

Unburned Areas - Generally, the unburned areas are forested green landscapes surrounded by a mosaic, low intensity burn. The edges of the islands are uniform, surrounding the forested landscape that appears natural and has all positive elements of form, line, color, and texture.

VIII. CURRENT SCENIC CONDITION IN BURNED AREAS - 1994, Version 1.0

The fire suppression activities of cat lines and hand fire lines have left significant scars in the landscape resulting in strong linear corridors, contrasting soil color and uniform edges.

IX. DESIRED SCENIC CHARACTER IN BURNED AREAS - 1994, Version 1.0

The desired scenic character is a mosaic pattern that displays all characteristics of the four different fire intensity levels (high, moderate, low, and unburned) in a manner that blends with land or rock form. In the long term, blend character and condition to be in harmony with the land form so the desired scenic condition provides a composition of mosaic patterns with form, line, color, and texture to resemble the characteristic landscape while attaining the future desired scenically-sustainable landscape. (See VI. Ecosystem Management Options by Zones for Scenic Resource Chart in this document). Maintain the positive elements of vertical trees, not horizontal trees, that will appear jack-strawed and dominating in time. (Need a balance of snags, both standing and down so that in the future, down snags do not dominate).

High Intensity Burn - From foreground view, the desired scenic character is to maintain a balance of the elements of line and color for spatial structure and diversity in sequence of experience for viewing. Maintain a mosaic composition pattern of patches of the burned area next to small-scale openings. Thin from below to allow leaving larger-diameter snags and clean up forest debris and snags to avoid jack-strawed effects of down snags in the long term. In middleground viewing areas, leave clumps or islands of snags (elements of line) to break up the overall dominating element of a uniform black landscape.

Moderate Intensity Burn - From foreground view, the desired scenic character is to leave a greater amount of brown (and green) vegetation to give the effect of a denser, more textured pattern. This is in contrast with high intensity burned areas, which may appear more open. In middleground views, maintain a mosaic, irregular-shaped, organic-flowing form of brown, highly-textured, burned areas as contrasted with the uniform, high intensity burned landscape, which may appear more open.

Low Intensity Burn and **Unburned Areas** - In foreground view, maintain the existing diversity of mosaic live green trees and shrubs intermixed with swirls of brown vegetation to give the greatest sense of variety and sequence of experience when travelling through the area. In time, rejuvenated vegetation and composition of vegetation patterns, such as open park-like stands of ponderosa pine, may be enjoyed.

X. DESIRED SCENIC CONDITION IN BURNED AREAS - 1994, Version 1.0

The desired scenic condition is to have a landscape that is dominated by the natural appearance of positive human-caused activities or alterations. The goal is to have a forested green natural appearing landscape as soon as possible. Evidence of human alterations and mechanical treatments (stumps, lines, slash piles, etc.) should be subordinant to the characteristic landscape. Rehabilitate fire management activities of fire lines to help blend them into the landscape.

XI. SPECIAL PLACES

Sense of Place - "Sense of place is a wholistic concept that focuses on the subjective and often shared experience or attachment to the landscape emotionally or symbolically." (USDA, Place Assessment, Pg. 1)

The importance of this concept is that it places humans in the landscape and is a tool to help managers understand the importance of places to people when doing planning or management activities.

Entiat Watershed, Version 1.0

The Entiat Valley places and features are numerous. People relate to the landscape in a broad sense in the Entiat Valley. Within the Valley, the following places or features are valued and are identifiable as unique, different, distinctive, and extraordinary to people:

1. Glacier Peak Wilderness
2. Upper Mad Lakes
3. Myrtle Lake
4. Entiat Meadows
5. Shady Pass
6. North Fork
7. Maverick Saddle
8. Entiat Valley
9. French Corral
10. Mud Creek
11. Silver Falls
12. Box Canyon
13. Tyee
14. Chumstick, Sugar loaf
15. Devils Backbone
16. Cougar Mountains
17. Lower Mad River

The quality of the Entiat Valley is the quietness and less-crowded nature of places that are interconnected by the travel routes.

Columbia Breaks, Version 2.0

Special places occur at different scales of the ecosystem from the larger scale, such as the U.S. Highway 97 corridor, to the smaller scale such as a rock outcrop that offers a vista view at Birch Mountain. The Columbia Breaks area has features and attractions that have special value. The following places are valued and are identifiable as unique, different, distinctive, and extraordinary to people:

1. Birch Mountain
2. Lincoln Rock
3. Swakane Canyon
4. Earthquake Point
5. Numeral Hill
6. Dick Mesa
7. Johnson Creek
8. Oklahoma Gulch
9. Navarre Coulee
10. Columbia Breaks Fire Interpretive Center
11. Columbia breaks backdrop, basalt cliffs and geology
12. Rocky Reach Dam
13. Forest Mountain
14. Entiat Mountain range
15. Columbia River
16. Lake Entiat
17. Ribbon Cliffs
18. Chelan Mountain range

The Columbia breaks of the watershed serves as a scenic backdrop from U.S. Highway 97 and 97A, U.S. Highway 2, Highway 971 and the rural communities and summer homes along the Columbia river. The communities include Wenatchee, East Wenatchee, and the Rocky Reach Visitor Center, and Orondo, Entiat, Desert Canyon Resort, Sun Cove, and Lake Entiat. The setting is rural with an agricultural feel; predominately fruit orchards exist along the Columbia River. The scenic backdrop is steep dissected slopes with a variety of vegetation patterns from sparse to moderately-dense coniferous forest throughout. The tributaries have high-density vegetation patterns.

In the Entiat watershed, two other special areas are identified. These are the Lake Basin ponds and the Experimental Forest.

XII. NOTES FOR PROJECT DESIGN Entiat Watershed, Version 1.0

NEPA (next phase), **Issues and Desired Scenic Condition and Character**

1. Trails #1409, 1410, 1411, 1413, 1415, 1416, 1418, 1448 and 1454 travel through a variety of scenic conditions and through scenic characters of the high, moderate, low, or unburned forest. Portions of these trails have been degraded due to the fire suppression activity of building cat lines on or adjacent to the Trails.

   The foreground of the Trails should be managed to be naturally appearing and provide a natural-appearing to semi-primitive recreation experience. (WNFP IV-207). Trails #1409, 1410, 1411, 1413, 1415, 1416, 1418, 1448 and 1454 will be aesthetically improved and provide a safe recreation experience as the trailside zone is rehabilitated.

2. French Corral Road #5800 provides foreground and middleground viewing opportunities along the canyon drive and a panoramic view on the ridgetops along the Entiat Mountain range from Chumstick Mountain to Sugarloaf, with access continuing into the Wenatchee watershed. The Shady Pass Road #5900 provides scenic access from the Lake Creek basin along the ridge towards Shady Pass and to the Chelan Mountains and Lake Chelan watershed. Views from both viewsheds are spectacular, with distance-viewing vistas of the forest.

3. The Tyee Ridge Road #5700 provides both foreground and middleground views towards Entiat drainage and towards the Mad River watershed. Trailheads along the Road provide access into the Tyee Mountain and Mad River watersheds.

4. Forest Roads #5300, 8410, and 5380 provide a loop opportunity and a short, but interesting drive through the landscapes in Mud Creek, North Fork of Mud Creek and Potato Creek.

Other Recreation Roads

1. Forest Road #5605, Tommy Creek Road, provides foreground and middleground views along Tommy Creek and into Entiat drainage. The trailhead at the end leads into Klone Peak.

2. Forest Road #5608 provides foreground views and access to a trailhead that leads to the North Fork of Entiat drainage.

3. Forest Roads #5200, 5210, 5801, 5703, 8410, 8500 and 5904 provide access to dispersed recreation opportunities throughout the watershed.

Questions

1. What portions of existing trails may be aesthetically improved? Are the trailheads adequate for use patterns?

2. Are there recreation sites or use patterns that should be eliminated or modified for social or biological considerations?

3. What will the cumulative effects be on the scenic resource, as a result of private salvage logging on burned areas?

4. What trees need to be removed, from a safety stand point, while still meeting established Scenic Quality Objectives?

5. Where is it feasible to leave a variety of high, moderate and low intensity burned areas for interest and scenic variety?

6. How will salvage logging and removal of trees fit-in to attain a balance of scenic character and condition in a manner such that the activity blends into characteristic landscape?

XIII. GLOSSARY OF TERMS

Landscape Character: Particular attributes, qualities, and traits of a landscape that give it an image and make it identifiable or unique.

Natural-Appearing Landscape Character: Landscape character that has resulted from human activities, yet appears natural, such as historic conversion of native forests into farmlands, pastures, and hedgerows that have reverted back to forests through reforestation activities or natural regeneration.

Rural/Agricultural Landscape Character: Landscape character that has resulted from extensive human activities and no longer appears natural (e.g., conversion of native landscapes into extensively-cultivated farmlands, vineyards, pastures, or an area of intensive domestic livestock production).

Scenic Integrity (condition): State of naturalness, or conversely the state of disturbance, created by human activities or alteration.

Scenery Management: The art and science of arranging, planning, and designing landscape attributes relative to the appearance of places and expanses in outdoor settings.

Appendix E
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Vegetation

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Appendix E-1

Vegetation Analysis
Entiat Analysis Area

Introduction

This vegetation analysis draws heavily from the Draft Mission Creek Watershed Assessment Vegetation Analysis (unpublished) and as a result has similar format. This analysis will look at the current and historic conditions in the Entiat analysis area. Current conditions were derived from vegetation maps from two sources: PMR (Pacific Meridian Resources) satellite imagery from the late 1980's and from aerial photo interpretation efforts in the late 1970's. Both of these maps did undergo some ground truthing to verify the mapped polygons, and while they do contain some errors, they are the best data sources available at this time. The focus of the vegetation analysis is multi-faceted in that it addresses conditions prior to white settlement and prior to the large recent fires (Tyee and Dinkleman), in addition to current conditions. Although somewhat convoluted, it is important to look at conditions in each of these time periods to better plan for the future. Further, vegetation is addressed by both climax potential (Series/Zone and Association) and standing condition (successional stage and structure) wherever possible.

Natural Range of Variability

The term "natural variability" refers to the variation in composition and structure, and dynamics of ecosystems across landscapes prior to European settlement (Swanson et al. 1994). As pointed out by Swanson et al. (1994), we have adopted the concept that managing an ecosystem within its range of natural variability is the best means of maintaining biological diversity (biodiversity). A biologically diverse ecosystem is resilient because of the high variety of structures, greater number of species and different successional stages present on the landscape.

The eastside forest ecosystems are inherently diverse. This is particularly true of the Wenatchee region. Inherent vegetation patterns across landscapes are determined by geomorphology, soil, and micro- and macroclimates, while induced diversity is the result of disturbances by fire, water, wind, animals and humans (Thomas et al. 1979, Hall 1980, Hall 1984, and Johnson and Clausnitzer 1991). The recurrence of fire is promoted by a set of environmental conditions, particularly important are lightning storms, but Native Americans also set many fires (Agee 1994, Johnson et al. 1994, McCleery 1994). These two ignition sources, along with fuels, weather and topography, influence fire spread and behavior, and affect landscape pattern, composition and structure (Hall 1984, Agee 1994).

In pre-settlement times, the vegetation in the Entiat analysis area and elsewhere on the eastside was strongly influenced by periodic disturbance, particularly fire (Weaver 1951, Cooper 1961, Weaver 1961, Mutch 1970, Arno 1980, Swetman and Dieterich 1983, Barnes 1987, Gast et al. 1991, Agee 1994, Johnson et al. 1994, Harrod et al. in press [a]). Disturbances in ecosystems are important mechanisms of succession which provide for landscape diversity. In addition, native species have adapted to and, in part, evolved with natural disturbance events (Cooper 1961, Mutch 1970, Buckley 1984, Taylor and Fonda 1990, Swanson et al. 1994, Harrod et al. in press [a]). For example, many grasses are able to survive fire because: 1) meristematic tissue is beneath the ground; 2) only one-year's growth is consumed by fire rather than many years accumulated by woody plants; and 3) reproductive age is reached early (Cooper 1961). *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir) have thick, fire-resistant bark. Some plants may have actually evolved to be more flammable. Increased flammability acts as an agent of interspecific competition by damaging competitors, as long as individuals of a species can tolerate or quickly regenerate after fire (Mutch 1970, Buckley 1984). Therefore, fire is an important ecological process that, in part, creates diversity in landscapes, communities and species, and provides for resiliency and dynamism. Furthermore, when pertur-

bations within an ecosystem fall outside the range of natural variability, biodiversity is lowered and resiliency is lessoned.

This document attempts to describe "historic" vegetation in the Entiat River drainage prior to European influence and describes current vegetation conditions. Once this has occurred, historic and existing vegetative conditions are then compared. The analysis area has been stratified by potential vegetation, but an emphasis is placed on community structures and compositions that result from disturbance, especially fire. Plant communities with similar fire regimes and resultant landscape vegetation patterns have been consolidated into groups. Historic vegetation patterns were determined by a combination of: (1) extrapolation from existing vegetation conditions based on successional dynamics and professional judgement; and (2) historic reports.

Landscape: Vegetation and Land Surface Attributes

Existing Conditions - General

See map entitled, "PMR Successional Stages" for pre-Fire distribution of vegetation and successional stages in the Entiat Analysis Area (circa 1986) and Appendix E-1.3 (Figure 1). Essentially, three temporal periods will be addressed when describing the vegetation of the Entiat analysis area including: pre-settlement; pre-Dinkleman and Tyee Fires (1986 information); and current. Please note that pre-settlement vegetative conditions are mostly conjecture. Although not addressed in this document, during the watershed analysis process, we will attempt to make some inferences about future vegetative conditions.

The Entiat analysis area is located such that the tree series that are present reflect elements of both Methow vegetation patterns (where grand fir is very limited) and Wenatchee Mountains (vegetation where grand fir is the major climax zone on uplands [Table E-1.1]). In the Entiat, grand fir is very uncommon north of the Entiat River but becomes quite common to the south. Further, the only real elements of maritime-influenced vegetation are in the very headwaters of the drainage nearest to the Cascade Crest, where the limited amount of silver fir indicates maritime climatic influences. The typical vegetation zones encountered with increasing elevation would be shrub/steppe, ponderosa pine, Douglas-fir, grand fir (south of river), subalpine fir and alpine meadows/parkland. The alpine types are quite limited in extent.

TABLE E-1.1

Commonly Occurring Tree Series by Watershed

(Upland Zones Only)

Tree Series	Methow	Chelan	Entiat	Wenatchee	Total Number of Watersheds
ABAM	m	m	m	M	4
ABGR	--	--	M	M	2
ABLA2	M	M	M	M	4
PIPO	m	m	m	m	4
PSME	M	M	M	M	4
TSHE	--	--	--	M	1
TSME	m	m	m	M	4
Number of Tree Series	**5**	**5**	**6**	**7**	

Legend

M = Major upland zone
m = Minor upland zone
-- = Essentially absent

As mentioned above, original stratification was by vegetation series, but subsequent vegetation "groups" were identified with similar disturbance regimes--much like the approach taken by Agee (1994) and in the Mission Creek Watershed Assessment (1995). The vegetation groups were delineated based on structure, physiognomy, tree species presence and tree canopy density. The groups reflected a similarity in fire frequency and, to some extent, similar intensities of fire events as well. These groups included:

SHRUB/STEPPE GROUP - Dry plant communities dominated by shrubs, grasses, or both. Tree canopy cover is less than 10 percent and trees are ponderosa pine or less commonly Douglas-fir. Common and dominant shrubs are bitterbrush and sagebrush. Common grasses are bluebunch wheatgrass, junegrass, Sandberg's bluegrass, and bottlebrush squirreltail. In the Entiat, this group is found below the Forest margin or on drier sites within the forested areas. Elevations range from 500 to 4500 feet.

OPEN FOREST GROUP - Open forest communities, mostly at lower elevations on relatively dry sites. Commonly have grass or shrub understories similar to the Shrub/Steppe Group and tree canopy covers of 10-50 percent and Grass/Shrub cover of 10-90 percent. Ponderosa pine and Douglas-fir are the dominant trees; grand fir occurs on some sites. These stands are essentially a transition between the shrub/steppe below and the closed forest above. Elevations range from 500 to 4500 feet.

CLOSED FOREST GROUP - Closed forest communities with tree canopy covers of over 50 percent with various understory species. Typical elevation ranges are between 1500 and 4500 feet. May occur on north slopes at lower elevations and southerly aspects in the subalpine zone. Climax tree species are either Douglas-fir or grand fir. Ponderosa pine and to a lesser extent lodgepole pine are seral tree dominants. This group combines fairly dry stands with relatively low site productivity and moist closed forest stands with fairly high site productivity. Fire-return intervals are somewhat longer in the moist end of this group.

CLOSED SUBALPINE GROUP - Closed subalpine forest communities with tree canopy cover of over 50 percent with various understory species. Typical elevations for this type are between about 4500-6000 feet. This group can be found at lower elevations in cold air drainage areas and on north slopes. The predominant climax tree species in this group in the Entiat is subalpine fir. Lodgepole pine is the typical seral tree stand dominant.

OPEN SUBALPINE GROUP - Open forest/park land interspersed with subalpine and alpine meadows typify this group. Stands do not close over (canopy <50 percent) and understory composition is commonly low shrubs, forbs, and graminoids. Conditions are often cold and snowy at the typical elevational range of this group (4500-7500 feet, with most above 6,000 feet). Common trees are subalpine fir, Englemann spruce, whitebark pine, and sub-alpine larch. Mountain hemlock has limited distribution in the Entiat.

The distribution of these groups by Fish Production Unit (FPU) is displayed in Appendix E-1.2 (Table 1). This Table displays the distribution of these vegetation groups throughout the analysis area. These types are based on the potential of the landscape to support this type of vegetation--whether in a currently burned condition or not. Appendices E-1.4 and E-1.5 (Tables 2 and 3, respectively) are compilations of the acres in the Entiat analysis area by land surface condition and by successional stage (where applicable). Information is based on both pre-Dinkleman and Tyee Fires (1986--Appendix E-1.4, Table 2) and post-fire conditions (1995-Appendix E-1.5). Appendix E-1.6 (Table 4) displays the acreage burned by FPU in all vegetative groups and for riparian, although these do not include data from the Dinkleman Fire.

Distribution of vegetative groups was primarily derived by delineating vegetation stands or polygons using Pacific Meridian Resource (PMR) maps. These maps originated from satellite imagery with some modelling and field checking for verification. Successional stages were determined using size class alone, and land surface condition of vegetation types came from PMR classes. Limitations of data precluded more specific mapping of vegetation types or more precise identification of successional stages. Note that the acreage values presented are estimates. Post-fire effects were interpreted from fire intensity data and estimates made from post-fire photos. Tyee Fire recovery efforts made considerable use of GIS data, while the Dinkleman Fire effects were estimated almost solely on inspection of photos and hand calculations.

Successional stages were based on size/structure data from PMR maps. The early classification corresponds to the seedling/sapling/pole size (<9 inches diameter) for all groups. The mid-successional stage is measured by trees in the 9 to 23 inch diameter size for the open and closed group and the 9 to 16 inch diameter size for the subalpine groups. Late successional stages in the open and closed groups were stands with trees larger than 23 inches in diameter and late successional subalpine groups had trees greater than 16 inches in diameter. These are gross estimates of successional stages and consequently the actual values are to be taken in light of the method of determination.

Data from ecology plots taken primarily in the late 70's and 80's have also been used to provide general information about some vegetation groups. Some of these 1/10-acre plots provided information on tree age, trees per acre, basal area etc., and were used where appropriate. These data were also used to better define vegetative composition of some groups.

A discussion of each vegetation group and specific methods is provided below.

Species of Concern

There are a number of plant species in the Entiat analysis area which are of particular concern from an ecological perspective. In general, there are two main groups of species which deserve special consideration; introduced species (weeds) and rare or unique species. A list of specific species and their locations is provided below.

Riparian Vegetation

Riparian vegetation exists throughout the Entiat analysis area. Each upland vegetation type has associated riparian vegeation along the stream channels. The extent of this vegetation is dependent on the number of streams in each area and the size of each stream. Typically, larger streams will have larger associated riparian areas. Consequently, the amount of riparian area is based on buffering the stream orders by a fixed horizontal distance to make an estimate of the amount of riparian zone. These buffer sizes, by stream class, were:

Class I = 300' **Class II** = 300' **Class III** = 150' **Class IV** = 100'

The area of riparian zone estimated for the Entiat (ca. 31,815 acres) is distributed throughout all vegetation types (refer to Appendix E-1.6, Table 4 and Appendix E-1.7, Figure 2) and is displayed by FPU. Riparian vegetation acreage is not separated out in the upcoming vegetation groups, rather it is included in the acres of various groups.

Existing Condition

Approximately ten percent (ca. 31,815 acres) is estimated to be riparian vegetation (Appendix E-1.6). These vegetation types are found, throughout the Entiat analysis area, adjacent to various streams. Composition of these communities is highly variable from low to high elevation. Approximately, 27 percent of the riparian areas were burned by the Tyee Fire. **Note**: Acres of riparian that were burned in the Dinkleman Fire are not included in these figures.

Often, some upland species from adjacent stands have the capability to become established in riparian conditions. In a shrub/steppe environment, conifers are typically absent from riparian zones. As adjacent vegetation supports conifers, there is some establishment of these trees in riparian zones--depending on the type of riparian area. Some very wet riparian conditions preclude the establishment of most conifer species even when conifers dominate in the uplands. In these wet sites, *Picea engelmmannii* (Englemman spruce) and *Thuja plicata* (Western redcedar) are the most likely conifers to survive. Typically, riparian plant communities are dominated by hardwood trees and shrubs including *Acer macrophyllum* (bigleaf maple), *Alnus incana* (mountain alder), *Cornus stolonifera* (red-osier dogwood), *Populus tremuloides* (quaking aspen), *Populus trichocarpa* (black cottonwood), *Salix* spp. (willow species), and *Ribes* spp. (currants).

Many of these areas were burned in the Dinkleman and Tyee Fires. When the riparian areas burned, they often appeared devastated, however, these areas are the first to sprout after fire due to the available soil moisture. The high soil moisture content seems to insulate many species from being killed by fire even when the above-ground stems are consumed.

Historic and to a lesser extent current grazing have usually been detrimental to riparian areas. Past grazing was excessive and relatively uncontrolled. Riparian areas are favorite spots in which livestock congregate for shade, water and forage. Even today, relatively few livestock can significantly change the composition and condition of riparian areas because of the detrimental effects of congregation. Condition changes are related to soil compaction and bank breakdown. Compositional changes occur when native and/or weedy species replace the natural vegetation. Additionally, beaver removal has probably caused significant changes in riparian zones in the analysis area.

Historic Conditions

In pre-settlement times, it is doubtful that riparian areas burned very often. Fire would have tended toward higher intensities when these areas did burn. The high fire fequency in many of the adjacent uplands would have made fire common--however it us uncertain how often the riparian zones would actually burn. Historically, the riparian zones often would have been unburned islands in a mosaic of burned and unburned landscapes.

Vegetative composition was probably different than currently. The presence of beavers, the lack of domestic grazing and the lack of exotic plant species would have contributed to a significantly different riparian zone in pre-settlement times.

Discussion

Riparian areas serve as critical components in any landscape; including the Entiat analysis area. Maintaining the quality and character of the riparian zones is then key to the maintenance of natural process and function in the analysis area. Riparian areas are the source of water in a dry landscape, major corridors for wildlife movement and typically unburned refuges for numerous species. It is quite likely that the degradation of stand character is felt more dramatically in riparian zones than any other. Consequently, these areas should be high in priority for necessary restoration.

SHRUB/STEPPE GROUP

(Including shrubland and grassland communties)

Existing Condition

Approximately 23 percent (ca. 73,600 acres) of the Entiat Analysis Area is comprised of primarily shrub/ steppe communities (Appendix E-1.2). These community types mostly occur below the lower Forest boundary and down to the Columbia River, although non-forest vegetation up to 4500 feet has been included in this type (PMR successional stage map). South-facing slopes in the ponderosa pine zone, however, will also be dominated by grass or shrub communities. Further, some drier and warmer microsites in the Douglas-fir and to a lesser extent the *Abies grandis* (grand fir) zones may also support open communities dominated by grasses and shrubs.

The limited number of ecology plots from these types indicate that the typical plant associations are dominated in the herbaceous layer by *Agropyron spicatum* (bluebunch wheatgrass) with or without either *Purshia tridentata* (bitterbrush) or *Artemisia tridentata* (sagebrush) or both as the shrub components. *Festuca idahoensis* (Idaho fescue) may occur in moist, generally concave, microsites. *Balsamorhiza sagitata* (arrowleaf balsamroot), *Eriogonum niveum* (snow eriogonum), *Eriogonum heracleoides* (parsley-flowered buckwheat) and *Poa sandbergii* (Sandberg's bluegrass) are common associates. Although we did not sample any vegetation in this "zone," a walk-through and visual estimate suggests that climax vegetation fits the *Purshia tridentata/Festuca idahoensis* habitat type described by Daubenmire (1988). The most conspicuous shrub in this habitat type is bitterbrush which is well dispersed over a dense herb layer of grasses, primarily Idaho fescue and bluebunch wheatgrass, and forbs (most obvious is balsamroot); Daubenmire 1988.

Little is known about the successional condition of many of these communities. Typically, the sere is abbreviated in shrub/steppe communities (in comparison to forested sites) because shrubs and grasses are usually more rapid developing and the early successional stages do not preclude the establishment of the climax species to the distant future (as in many forested scenarios). Further, although perennial grasses and shrubs can be very long lived, the effects of shading on climax species establishment is not as pronounced in shrub/steppe environments. Consequently, fire does not typically set succession back too far in these environments. As a result, most acres in both pre-and post-fire conditions were listes as mid-successional. Only a few acres were classified as being in early successional stages after the fires of 1988 and 1994 (Appendices E-1.4, Table 2 and E-1.5, Table 3).

However, there are other factors that affect succession in these open communities. Of major concern here are the effects of past and present ground- disturbing activities on the abundance and distribution of exotic plants. Once established in these open stands, exotics like *Bromus tectorum* (cheatgrass) and *Centaurea diffusa* (diffuse knapweed) are maintained essentially forever. The presence of species like these will then change the potential of the sites. No longer will the natives achieve the prominence that they once enjoyed in these stands. Past livestock grazing (mostly cattle and horses) has been a major contributor to the ground disturbance that has allowed exotic weeds into these stands.

Historic Conditions

Little is known about the historic fire regime and resultant vegetation composition and pattern in grass- and shrublands (Agee 1994). This is mainly true because there is no consistent and accurate way to date past fire occurrences (like fire scars in conifers). However, some logical speculations can be made.

Total number of acres and distribution of shrublands was likely greater than today. This assumption is based on evidence suggesting that many eastside plant series have short fire-return intervals (Agee 1994, Barnes 1987, Finch 1983, Agee 1991). Although most of these data are from forested series, it is reasonably applicable to dry non-forested conditions, as well. Further, anecdotal evidence indicates that lightning-caused fires are common in this vegetative zone on an annual or biennial basis even today. These frequent disturbance events kept ponderosa pine more scattered and park-like or absent from the lower elevations of the analysis area. What currently exists as dense ponderosa pine and Douglas-fir at the lower elevations and on south-facing slopes was likely seral grassland communities. Daubenmire (1988) notes that in the Cascades foothills, the bitterbrush/Idaho fescue alternates with the ponderosa pine/bitterbrush habitat type. The only difference between the two habitat types is the presence of a ponderosa pine layer. A distinct ecotone between the two types was probably even more vague than it is currently. Also, bitterbrush and sagebrush were probably less abundant and consisted of newly-sprouted individuals, since they are generally killed by fire (Agee 1994).

Evidence for this vegetation condition can be seen in photos taken in the late 1940's (USFS Aerial Photos 1949). In these photos, ponderosa pine tends to be more scattered and widely spaced on the lower slopes than it is today. Also, additional acres of low elevation land haves come under development in the past 100 years. A large portion of this developed land would most likely have been dominated by shrublands.

OPEN FOREST GROUP

(Including open ponderosa pine, Douglas-fir and grand fir communities)

Existing Condition

The plant series and associations in this group have been lumped together because of similar fire regimes and vegetation patterns (Hall 1976, Johnson and Clausnitzer 1991, Williams and Smith 1991, Agee 1994). Very little of the true ponderosa pine series stands support closed forests, so all stands in this zone are included here. However, both the grand fir and Douglas-fir series typically support closed forest so only open forest (those stands with less than 50 percent tree canopy) are included in this type. This unit is mainly composed of sites within the Douglas-fir and ponderosa pine series that never had the potential to close over. Only a few of these sites support grand fir as the climax tree species. The conditions here are very similar to those described by Agee (1994) as the *Pinus ponderosa* series. The typical plant associations within this group include: PIPO/CARU-AGSP, PIPO/PUTR/AGSP, PSME/AGSP-CAGE, PSME/ARTRV, PSME/ARUV-PUTR and ABGR/ARUV (Williams and Smith, 1991).

A large portion (17 percent; ca. 56,000 acres) of the Entiat analysis area supports the open forest group (Appendix E-1.2 and PMR Successional stage map). Although the Dinkleman and Tyee Fires have caused some changes in these types of stands, the change has not been as dramatic as that in the closed forest environment. Prior to the recent fires, there were probably more trees present than in pre-settlement times. This would have resulted in some higher burn intensities. However, even with fire suppression, much of the open forest landscape did not support adequate fuel loading to result in high intensity burns--which cause stand replacement. Prior to the large fires of 1988 and 1994, approximately 35 percent of this group was in late successional stages, ca. 57 percent in mid-successional stages and the remainder in early successional condition (PMR map and Appendix E-1.4, Table 2). As a result of the 1988 and 1994 fires, much more of this vegetation type is in early to mid-successional stages (Appendix E-1.5, Table 3). Although these rough estimates are based primarily on tree size distribution, they do not seem unreasonable for the analysis area. Similar to the shrub/steppe environment, the biggest changes here are the effects of past livestock grazing and other .round-disturbing activities on the populations of exotic plant species. Once established in these open stands, exotics like *Bromus tectorum* (cheatgrass) and *Centaurea diffusa* (diffuse knapweed) will remain.

For the plant associations listed above for this group, the average number of trees per acre is approximately 156 and the mean basal area is ca. 115 sq.ft./acre (Williams and Smith, 1991). The quadratic mean diameter for all trees was ca. 14.4 inches. Site index and growth basal area (GBA) values were visibly lower than most other forested types found in the analysis area, however, some associations had no tree data. It is suspected

that these numbers may be a bit high since few stands were sampled in these sites and the lower productivity sites often lacked adequate sample trees.

Historic Conditions

A relatively large number of publications exist which describe fire frequency and effects in dry, eastside forest environments. The fire-return interval in these forest types tended to be short, approximately 20 years or less, and of low intensity (Hall 1976, Hall 1980, Finch 1983, Hall 1984, Gast et al. 1991, Mutch et al. 1993, Agee 1994, Johnson et al. 1994, Harrod et al. in press [a]). On the Okanogan National Forest (Finch 1983), it was found that on sites similar to this group, pre-suppression fire frequencies were high (4-17 years in ponderosa pine stands within similar plant associations). Finch (1983) further concluded that fire frequencies were similar to those reported by others east of the Cascades and/or in the Rocky Mountain States. One study carried out on a 70 to 80-acre stand in a portion of the Mission Creek watershed (where sites are very similar to the Entiat drainage) showed a fire-return interval of 17.6 years (Richard Schellhaas, Wenatchee Forestry Sciences Laboratory, pers. comm.). Preliminary work of a similar nature, by the same worker, produced a fire-return interval of under eight years on a 700-acre stand in the Entiat. Barnes (1987), working in several areas of the Entiat, came up with similar results. High fire frequency was the norm until fires were suppressed by government agencies, particularly the Forest Service, which began extinguishing fires in 1906 (Wickman 1992). By the 1930's (Mutch, et al. 1993), they had become increasingly efficient in their suppression techniques. The last date recorded by fire scarring in the Mission Creek fire history study was 1929 (Richard Schellhaas, Wenatchee Forestry Sciences Laboratory, pers. comm.). It is interesting to note that heavy sheep grazing began to decline from approximately 150,000 animals down to about 3,000 in the early 1930s (Forest Service records, Wenatchee NF Supervisor's Office). This decrease in sheep numbers and efficient fire suppression would have encouraged understory tree growth.

Under a frequent fire regime, the vegetation types that typically do not have the potential to support closed forests were not drastically different from what we see today. If not for the two large fires in the last six years, the number of trees per acre would probably be somewhat higher now. As it is, the less fire-tolerant Douglas-fir may still be a bit more abundant than what historically occurred.

Patch sizes, under a frequent fire regime, tended to be small in this dry series (<1 acre; Agee 1994), and landscape patterns were dominated by a park-like structure of widely-spaced trees with a continuous herbaceous understory (Hall 1976, Hall 1980, Hall 1984, Gast et al. 1991, Mutch et al. 1993, Agee 1994). Fire-resistant ponderosa pine was commonly the dominant tree on most sites. Typically, these sites are too dry for trees like *Larix occidentalis* (western larch) and *Pinus contorta* (lodgepole pine). Although, sometimes these trees could be found in the cooler, more moist microsites within these open forest types. The presence of Douglas-fir on dry Douglas-fir or dry grand fir sites depended on occasionally longer fire-free intervals. This allowed the Douglas-fir to develop thicker fire-resistant bark not found on young trees (Agee 1991, Agee 1994).

If not for the Tyee and Dinkleman Fires, the number of trees per acre in this zone would likely have been less prior to settlement than what currently occurs. However, the artificially lengthened fire-free period, with its attendant increase in fuel loadings, undoubtedly increased the severity of the Dinkleman and Tyee Fires. This, in turn, killed many trees that historically would have survived. Consequently the current number of trees per acre in these open forest sites is probably somewhat less than the historic conditions. In areas not burned by these two recent fires, there are likely more trees per acre now than in historic stands. Vegetation patterns on the landscape must have been very stable, because fire intensities were low and patch sizes very small. Some of the oldest trees found in ecology-sampling efforts come from these dry, open stands (typically fire-scarred ponderosa pine 250+ years old) often with numerous fire scars. These factors all point to a relatively stable, low-intensity fire environment.

The following describes what probable vegetation patterns and structures were present in the dry, open forest group. Again, these assumptions were based on a review of historic documents (Gorman 1899, Plummer 1902, Washington State Land Exchange, 1915) and current vegetation structures.

The most likely historical landscape patterns and compositions are as follows:

Most Likely Historical Landscape Patterns and Compositions

Structure	Abundance
•Open parkland with herbaceous understory	80 - 95 percent +
•Small, closed forest Douglas-fir or grand fir inclusions with dense cover or stand replacement openings. †† AND	
•Open forest sites with understories over age 20 (occasional longer-than-average fire cycle). AND	<20 percent
•Riparian mesic Douglas-fir or moist grand fir inclusions with dense cover or stand-replacement openings.††† AND	
•Open forest sites at upper elevation margins with stand structures similar to the moist grand fir group.††††	

LEGEND

†	For forested land (>10 percent conifer canopy closure) mapped by the Mission Assessment as the dry series community group.
††	Conservative and liberal estimates of mesic Douglas-fir inclusions (minimum five acres) within dry community series range from 1.4 to 3.9 percent of the total area. Estimate inventoried steep north slopes, which appeared on aerial photos, to support high canopy closure. Riparian zones not included. Largely a result of convoluted and dissected landscape.
†††	Riparian inclusions, probably less than one percent of dry series group.
††††	Transition area where disturbance regime is probably more moderate than low intensity, especially where sites are buffered by more moist communities.

Discussion

Understory composition today may be very different than that prior to fire suppression, logging and grazing. The Entiat analysis area was intensely grazed by sheep prior to 1950 (Gorman 1899, Plummer 1902, USFS Allotment Cards on file at the Wenatchee National Forest Supervisor's Office, Shorty Long, 1994). Plummer (1902) states that: "upwards of 60,000 sheep were said to be ranging in this section...although grazing is mostly done at altitudes above the yellow pine zone."

Grazing continued at lower numbers until the late 1960's. In a similar watershed, Mission Creek, evidence from a grazing exclosure erected in 1939, in Pendleton Canyon, suggests that these activities have changed understory species composition. *Ceanothus velutinus* (buckbrush) is nearly absent from hillsides in lower Mission Creek, however, it can be found within the exclosure. In fact, shrub/grass/forb composition within the

exclosure is noticeably different than that in the surrounding forest. Lack of fire in these communities may have also influenced the presence or absence of certain species. Hall (1980 and references therein, Agee 1994) notes that *Ceanothus* seeds require heat treatment for germination. Other species also require fire for reproduction and vigor (see Agee 1994).

If not for the extensive fires in recent years, this open forest group would be quite different from the historic conditions. However these recent fires have, in this group particularly, returned much of the landscape back to the conditions once seen before European settlement occurred. Unlike the closed forest groups (discussed later) this and the shrub/steppe types have been maintained, by the recent fires, in a condition not unlike that which was seen historically.

Plummer (1902) noted that although mistletoe was present in the Entiat, it was not prevalent enough to injure the trees. This is not the case today, however, as mistletoe appears to be widespread and increasing within the analysis area. Frequent ground fires would inhibit the spread of mistletoe and would have pruned lower branches, which are often the most infected, or would have consumed entire trees with low hanging "witches brooms." Open stand structure with widely-spaced trees, the result of a frequent fire regime, is not as conducive to the spread of mistletoe as are densely-layered stands.

CLOSED FOREST GROUP

(Including closed Douglas-fir/grand fir communities)

Existing Condition

This group typically occurs on uplands from 2000-4500 feet in elevation. Grand fir is typically absent from stands north of the Entiat River; instead Douglas-fir becomes more common. This group includes closed forest stands of dry to mesic Douglas-fir and grand fir. Moist grand fir stands may better fit conditions found in the lower closed subalpine forest, but it was not possible to map a separate group with the current available data.

Steep south slopes within this range may support open forests while northerly aspects at lower elevation can support some closed forest conditions. Canopy cover of this group is over 50 percent. Higher elevations support mainly subalpine fir closed forest, which grades into subalpine parkland and finally alpine non-forest types. The plant associations represented in this group include: PSME/CARU-CAGE, ABGR/BENE, ABGR/CARU-LUPIN, ABGR/ARCO and ABGR/PTAQ/SPBEL.

Thirty-seven percent (ca. 119,200 acres) of the Entiat analysis area is mapped as closed Douglas-fir/grand fir (i.e., closed forest, Appendix E-1.3). Prior to the Dinkleman and Tyee Fires (of the 119,200 acres), approximately 37 percent (ca. 44,400 acres) was determined to be either early or late successional with ca. 74,800 acres (63 percent) considered to be mid-successional stands (Appendix E-1.4). This appears reasonable, although the actual acres for early successional stage appear to be too low (only ca. 3090 acres; PMR successional stage map). After the fires of 1988 and 1994, there are considerably more early seral stands and fewer late seral stands (Appendix E-1.5).

For the plant associations listed above in this group, the average number of trees per acre is about 500 in the grand fir types and less than 200 in the Douglas-fir types. Basal areas are over 200 sq.ft/acre except in the PSME/CARU-CAGE (they were considerably lower--suggesting that this type might be more closely associated with the open forest group). Quadratic mean diameters typically ranged between 9 and 12 inches for each association. Tree ages of site trees were from 78-113 years at breast height age.

Historic Condition

In the closed forest, closed Douglas-fir and grand fir associations, a moderate fire regime was present mixing low- and high-intensity fires (Agee 1991, Williams and Smith 1991, and Agee 1994). Drier sites within this group probably had fire frequencies under 20 years, while on the wet-end sites fire frequency was probably more than 20 years. This was not as frequent or as regular as fires in the dry series group. In the Blue

Mountains, Mutch et al. 1993 stated that fire intervals ranged between 40 and 150 years in the higher elevations and on moist sites at middle elevations. On sites where ponderosa pine was a major stand component, fire intervals were less (10-25 years). Most of what is currently closed forest in the Entiat (or was prior to recent catastrophic fires) at middle elevations, typically supported much more open conditions where ponderosa pine or western larch was maintained by frequently-recurring fires.

The physiognomy of stands in this group was maintained by fire to be like the open forest Douglas-fir/ ponderosa pine climax stands at lower elevations and on southerly aspects (discussed in the previous section). However, fire suppression, with its attendant reduction in fire frequency, has resulted in many of these fire-maintained open stands closing over (prior to Dinkleman and Tyee Fires at least!). This is at least partially corroborated by historic accounts of early pioneers who reported park-like stands of ponderosa pine with dense grass and little shrubs in the understory (Agee 1991, Wickman 1992, Agee 1994)--in areas that are now closed forest. Also, existing stand structures indicate previously open stands. Relatively large ponderosa pine (and few Douglas-fir) trees are, in many places, widely spaced with a dense understory of trees 12 inches or smaller. These trees were established shortly after fire suppression had begun and extensive sheep grazing had declined.

In the higher elevations and on moist sites at middle elevations, fire played a more complex and variable role in forest structure (Mutch et al. 1993). As in the Mission Creek watershed (Mission Creek Watershed Analysis, unpublished report), the small patch sizes of moist sites surrounded by fire-frequent patches likely lead to a somewhat shorter return interval. Stand-replacement patches were likely variable, ranging from less-than-one acre to much larger, depending on fuel availability and juxtaposition to other vegetation types. Left undisturbed, these typically more productive sites would accumulate biomass much faster than nearby drier sites. Therefore, they were more susceptible to moderate or intense fires on longer rotations. The moderate-intensity fires would typically set succession back by favoring the more fire-resistant seral tree species like ponderosa pine or western larch. On grand fir sites, the grand fir is so susceptible to even low-intensity burns it must have depended upon the islands of unburned areas to maintain itself in these stands. Consequently, this fire regime probably did not produce climax stands. True climax Douglas-fir forests require over 200 fire-free years to develop (Agee 1991), a rare situation in most of the area.

The following stand structures were probably well represented on closed forest Douglas-fir/grand fir sites:

Structure	Required Events
Open parkland with ponderosa pine or ponderosa pine/western larch, with or without Douglas-fir.	Moderate-intensity fire followed by frequent low-intensity fires.
Dense, two-canopy layers.	Former open parkland structure with fire exclusion for several decades or more.
Two or more layers. Stand density moderate to high, depending on recovery time since last fire.	Moderate-intensity fire kills 20 to 70 percent of dense stand (usually smaller trees). Understory trees establish in gaps to maintain layered structure.
Created openings and seeding sapling stands, with or without remnants.	High-intensity fire kills 70 to 100 percent of a dense stand, followed by tree regeneration.
Dense, single-layer pole stands, with or without remnants.	Stand-replacement fire followed by several fire-free decades.

In the cooler and more moist grand fir plant associations, fire-return intervals were longer (40-50 years) than in the previous series groups and fire intensity was of moderate severity (Agee 1994). However, low and high fire intensities probably occurred and patch sizes were small to very large. Such variable fire intensities created a very complex mosaic pattern in the moist grand fir associations (Agee 1991). Under severe fire weather, extremely large areas could be intensely burned. Moderate- to low-intensity fires, which occured more often, broke the large patches created by extreme fire events into smaller patches. These events combined to form complex landscape patterns that were highly variable in both space and time.

The following describes possible scenarios under different fire intensities (The intensity classes defined below originated from the Mission Creek Watershed Analysis.)*

LOW-intensity fires reduced tree basal areas by up to 20 percent. These fires tended not to initiate understory development.

MODERATE-intensity fire reduced tree basal areas from 20 to 70 percent, usually killing the smaller trees, the most susceptible species and the denser clumps. These fires usually resulted in the understory establishment of both seral and shade-tolerant species depending on gap size.

INTENSE stand-replacement fires reduced tree basal areas by 70 to 100 percent and created openings where shade-intolerant species could regenerate.

*For purposes of following structural analyses, the percent of tree-killed is defined below. Fire intensity determinations for BAER analysis do not use a specific percentage of tree mortality to identify the fire intensity levels.

In the Entiat analysis area, many moist grand fir sites are located in close proximity to other community types. Fire frequency on these sites must have been influenced by these neighboring stand structures and fire regimes. Probable stand structures and the causal agents are described below (Mission Creek Watershed Analysis 1995):

Structure	Required Events
Created opening and seedling and sapling stands, with or without remnants.	Intense fire kills 70 percent or more of a dense stand.
Dense, single-layered pole or small timber stands, with or without remnants.	Stand-replacement fire followed by several to many fire-free decades.
Two-layered stand with seral dominant overstory.	Moderate-intensity fire kills 20 to 70 percent of stand followed by understory establishment in created gaps.
Open parklike.	Moderate-intensity fire followed by a series of frequent low-intensity fires.
Two-layered stand with seral dominant overstory.	Former open parklike stand followed by several fire-free decades.

Like the low-intensity fire, moderate fire intensities probably did not produce climax grand fir stands because successional development of these stands would require a fire-free period in excess of 200 years. Very moist and protected riparian areas may be the exception.

In moist grand fir plant associations, the abundance of these structures across the landscape can be estimated if some assumptions are made about stand-replacing events. We have provided the following estimates:

Structure	% Moist Grand Fir Area
Created openings and seedling or sapling stands, ages 0 to 20, with or without remnants.	Thirteen to 20. (Assumes stand-replacement interval of 100 to 150 years.)
Dense, single-layered pole/small timber stands, ages 20 to 45, with or without remnants.*	Seventeen to 25. (Assumes stand-replacement interval of 100 to 150 years.)
Layered canopy with seral dominant overstory.	Fifty-five to 70. (100 percent minus above stand structures.)
Open parklike	Probably not well represented, but occurred where small sites are surrounded by drier forest types.
Climax Stands.	Probably rare. Possibly found in moist, sheltered riparian areas.

* Assumes fire-return interval of 45 years.

Discussion

Plant associations of the closed Douglas-fir/grand fir series, with moderate-severity fire regimes, do not experience low-severity fires because of fire suppression (Agee 1994). Therefore, the complex mosaic of stand types created and maintained prior to fire suppression favored seral, more fire-tolerant species over dominant, shade-tolerant species (Agee 1994). As a result, high-severity fires are now quite likely in the closed Douglas-fir/grand fir forest group.

Forests in the closed mid-elevation Douglas-fir/grand fir group in the Entiat have changed over the past century. The most significant change has been the dense colonization of a fire-protected age class of trees, particularly grand fir and Douglas-fir, throughout the landscape (see also Hall 1980, Gast et al. 1991, Mutch et al. 1993, Agee 1994, Harrod et al. in press [a]). In the Douglas-fir and grand fir associations, fire exclusion has not only changed tree density but a major shift to more shade-tolerant species has occurred (Agee 1994). Now, rather than low-intensity underburns being the "normal" fire regime in this dry series group, moderate- to high-severity fires have the potential to occur. Continuous horizontal and vertical fuels resulting from successional processes likely will result in large catastrophic fires. In addition, the potential for widespread insect or disease epidemics has greatly increased (Gast et al. 1991). This is not to say that damage or mortality caused by insects is undesirable, but unusually high tree densities provide the opportunity for unusually high populations of forest pests. Currently, a relatively large number of ponderosa pine trees within the analysis area are dying each year as a result of pine beetle infestations.

CLOSED SUBALPINE GROUP

(Including closed subalpine fir communities)

Existing Condition

This group is mainly comprised of plant associations within the subalpine fir series including: ABLA2/ARLA-CAGE, ABLA2/VAMY, ABLA2/PAMY, ABLA2/RHAL, ABLA2/TRCA3 and ABLA2/unclassified (Williams and Smith, 1991). The lowest mean elevation for any type in this group was 4620 feet (ABLA2/PAMY) and the highest was 5890 feet (ABLA2/VAMY). *Abies amabalis* (silver fir) and *Tsuga mertensiana* (mountain hemlock) are found only in the upper reaches of the Entiat drainage in maritime climate influence areas. ABAM/RHAL and

ABAM/VAME are the most common types. Mean type elevations are 5378 and 4517 respectively. The geographic extent of these two species is relativly small.

The lower elevational margin of this group is typically bounded by closed grand fir or Douglas-fir zone plant associations. Above is open forest/parkland and alpine/subalpine non-forest. In much of the Entiat River Drainage, where the highest peaks and ridges are below 6000 feet, this group comprises the highest elevation vegetation type. About seven percent or 21,000 acres of the analysis area were subalpine forest (Appendix E-1.3, Figure 1). Prior to the Dinkleman and Tyee Fires, 59 percent of these stands were late successional, 39 percent were mid-successional and only two percent were in early stages of succession (Appendix E-1.4, Table 2). This changed after the recent fires (refer to Appendix E-1.4, Table 2). Few acres of this vegetation type burned in the 1988 and 1994 fires. As a result, there was only a small change in successional status - primarily with more acres being classified as early instead of late (Appendix E-1.5, Table 3).

From a limited number of ecology plots taken in the Entiat (prior to 1988), which included tree information and were from stands in this group, some information can be gleaned. From 14 subalpine fir series plots: Mean trees per acre equals 885; mean basal area equals 313 square feet. The quadratic mean diameter for all trees was 10 inches and the average height of all trees was 77 feet. Mean breast height age of all trees was 148 years. From the four silver fir stands in the Entiat, the data were somewhat different. Mean trees per acre were 659; mean basal area was 278 square feet; quadratic mean diameter was 10 inches; and average height of all trees sampled was 112 feet. Mean breast height age of the dominant and co-dominant sample trees was 105 years.

Historic Condition

Fire-return intervals and fire intensities tend to increase in subalpine fir forests (Agee 1994). Fire-return intervals tend to be somewhere between 100 and 200 years (Agee 1994), however, more frequent fires, maybe less than 100 years, were probably common in areas where drier community types were immediatley adjacent to the subalpine zone. In parts of the Entiat drainage, where subalpine fir is at the lower elevational limit, fire-return intervals of more than 200 years are unlikely. However, some areas within the Entiat analysis area are at the upper elevational limits of the subalpine fir zone and consequently, burn less frequently. Many of these areas carry snow through most of the summer and then recieve new snow in September--making them relatively inflammable most years.

Fire intensities tended to be severe and mortality was high (Agee 1994). This is largely a result of plant morphology. Taylor and Fonda (1990) found that twice as much fuel accumulated at the bases of trees as compared to the forest as a whole. During a wildfire, these high fuel loads ignite sending flames into the dead branches of the trees which extend nearly to the ground (subalpine fir is not a good self-pruning tree). This allows fires to burn vertically and tree death is increased. Low to moderately-intense fires may have occurred when fires on drier slopes creeped into subalpine fir stands. Taylor and Fonda (1990) found that maximum flammability occured in early August in subalpine fir forests. It is not uncommon to have many fires in the East Cascades in drier forest as early as May or June. Such fires would begin burning out upslope as they entered less flammable fuels.

Forest patch sizes resulting from disturbance may have been small with a few large ones. Landscape pattern would have been highly variable, both in space and time, and would have been influenced by large-scale events. A forest condition report from 1902 (Plummer 1902) addressed conditions for 2.8 million acres in the Cascade range between the Washington and Mount Rainier Forest Reserves. It showed that much of the upper Entiat was in a burned condition at that time. Approximately eight percent or 204,000 acres of the area covered by the report were burned areas. In the Entiat, Plummer reported 15,500 acres of the 212,000-acre total as burned and his map shows much of this to be in the subalpine forest zone.

NOTE:The following discussion of successional information was taken, with only minor modifications from the Mission Creek Watershed Assessment (1995). It is equally applicable to the Entiat Analysis Area, however.

Forest structures and patterns were complex and are difficult to describe. The following discussion ignores, for the moment, the role and influence of moderate-intensity fire on vegetation structures. The focus here is on successional development.

Successional Stages - (Composition and Structure)

Successional Stage	Approximate Age	Composition and Structure
Early	0 - 30	Seral or mixed species, single-canopy layer (although it may have few remnants from previous stand). Structure ranges from created openings to seedlings, saplings or small pole stands.
Mid	30 - 120	Seral or mixed species. Single-canopy layer (as viewed from aerial photo). Large poles to small-size timber. Canopy height may be stratified by species, although trees of the same age class not considered a layered canopy. May have shade-tolerant seedlings, saplings or small poles developing in understory. May have remnants from previous stand.
Late	120+ (overstory)	Layered canopy as viewed from aerial photo. Seral species dominate overstory or codominant with shade tolerant. Shade-tolerant understory. Overstory in steady decline, especially if lodgepole pine.
Very Late/Climax	200 + (overstory)	Layered canopy, as viewed from aerial photo. Shade-tolerant species dominate overstory and understory. Replacement of seral sepcies by shade tolerant may take well over 200 years, provided a stand-replacement fire does not occur first.

Probable distribution of these forest structures on the landscape are as follows:

Stage	Approximate Age	If 200-year Stand Replacement Interval	If 150-year Stand Replacement Interval	Range
Early	0 to 30	30/200 = 15%	30/150 = 20%	15 to 20%
Mid	30 to 120	90/200 = 45%	90/150 = 60%	45 to 60%
Late	120+	80/200 = 40%	30/150 = 20%	40 to 20%
Climax	>200	Uncommon	Uncommon	Uncommon*

* Could develop on sites which burned at intervals well beyond the average....isolated sites with natural fire breaks?

The fire-replacement interval for specific sites also influenced by proximity of drier vegetation communities and fire regimes.

Moderate-intensity fires probably greatly influenced the structural development of subalpine fir sites in the Entiat analysis area. These fires, which probably occurred periodically between stand-replacement fires, would kill 10-50 percent or more of a stand and create opportunities for understory development. With moderate-intensity fires, mid-successional stands could develop layered structures more rapidly than by succession alone. This means that the landscape probably contained more layered stands (late-successional) and less single-storied stands (mid-successional) than estimated in the above table.

Stands located farthest from drier communties, at the highest of elevations or protected by natural firebreaksk, were probably least infuenced by down-canyon fires. On the other hand, subalpine fir stands located at the top of steep "chimneys" would be the most fire influenced.

OPEN SUBALPINE GROUP

(Including open subalpine forest/parkland and alpine meadows)

Existing Condition

About 16 percent (52,000 acres) of the Entiat analysis area has been mapped as open subalpine forest/parkland or alpine meadow (Appendix E-1.3, Figure 1). These types typically occur at or above the upper elevational limit of conifers, although, for this analysis, any open forest or non-forest acres over 4500 feet were included as open subalpine. Only a small portion of this type was impacted by the recent fires (Appendix E-1.4, Table 2 and E-1.5, Table 3). Ecology plot elevations in these types for the Entiat range from 6050 to 7320 feet. The lower elevational boundary is usually closed subalpine fir forest and the upper boundary is usually non-vegetated rockland, rubbleland or snow. Typically, northerly aspects at these extreme elevations will support open *Larix lyalli* (subalpine larch) stands, while southerly aspects have *Pinus albicaulis* (whitebark pine) as the dominant tree. It is common for areas above the tree line are commonly sparsely vegetated. Typically meadow vegetation is found interspersed with open forest. Moist concave areas, places with high snow pack or harsh dry sites support low-growing herbaceous vegetation.

Because of the unique nature of these communities and because of their limited geographical extent, these areas are of particular concern. Disturbances here do not heal quickly. Evidence of sheep grazing, often prior to the turn of the century, still exist in many places. This evidence often includes, small terracettes on green fescue-dominated (*Festuca viridula*) slopes to the unnatural dominance of wooly pussytoes (*Antennaria lanata*) in many meadows.

Another major disturbance on some of these sites has been the decimation of many whitebark pine stands by white pine blister rust.

We have placed most of the open subalpine forest/parklands in either mid or late successional stage--mainly based on intuition. Other than the areas dominated by whitebark pine, these stands almost never burn (Agee, 1994). Consequently, most of these areas have had a long fire-free interval and are successionally advanced. Conversely, many white-bark stands have been burned or are being severely affected by blister rust and are relatively early in succession. In fact, blister rust has ultimately altered the potential of whitebark pine sites.

Historic Condition

Judgement plays a major role in suggesting the conditions in this group prior to European settlement. Most of the subalpine open/non-forest sites would have seldom burned. Late snowmelt, moist conditions and non-flammable vegetation result in long fire-free intervals (Agee, 1994). Such was not the case with whitebark pine forest.

Fire has also played an important role in whitebark pine stands, in particular. Gorman (1899) mentioned that although fire in the "white-bark pine belt" did not result in loss of timber, soil damage was very great. The areas where whitebark pine is found are typically grass dominanted and probably the most flammable of the upper subalpine environs. Further, whitebark pine is very flammable even when green. These factors result in sites that have short fire-return intervals (Agee 1994, Arno 1986, Morgan and Bunting 1990).

Historically, then, open subalpine forests and non-forest were typically late successional, with very infrequent fire events. Lightning strikes were undoubtedly common but often did not spread, so patch size was small. Even in whitebark pine areas, where fire is more common, the size of most fires would have been limited to the aerial extent of contiguous whitebark pine stands. Usually, this is fairly small.

Appendices E-1.2 through E-1.4

The following pre-Tyee Fire and current vegetation tables and figures have been revised to include the additional 55,000 acres added to Version 2.0 of the Watershed Assessment (Columbia River Tributaries).

The pre-fire, PMR vegetation map and corresponding Appendices E-1.2, E-1.3 and E-1.4 are an approximation of the vegetation types and successional stages that existed prior to the Tyee and Dinkleman Fires. These vegetation stratifications were made using a combination of canopy closures, size/structures, and species composition attributes from the PMR satellite data layer. A manual adjustment was made in the upper elevational zones to compensate for the data sorting process, which groups the shrub/steppe and open subalpine types together. Generally, the number of acres of shrub/steppe above 4,500 feet in elevation were reclassified as open subalpine in the tables that follow. This correction has been made in the tables and figures.

Table E-1.2 **Entiat Analysis Area Vegetation Types by FPU.** Acreage distribution of vegetation in the Entiat Analysis Area by Fish Production Unit (FPU) and vegetation type (includes Dinkleman Fire).

FPU NAME	VEGETATION TYPE						
	Non-VEG	Shrub-Steppe	Open Forest	Closed Forest	Subalp Forest	Open Subalp	TOTALS
LOWER ENTIAT		14,270	8,502	1,365	0	657	24,794
LOWER-MID-ENTIAT		5,212	10,614	4,708	37	3285	23,856
UPPER-MID-ENTIAT		1,557	1,614	7,920	504	3286	14,881
UPPER ENTIAT		99	11	12,315	1876	3430	17,731
HEADWATERS ENTIAT		221	21	9,508	2951	12073	24,774
MUD		1,942	10,452	1,130	0	897	14,421
STORMY-POTATO		1,065	4,772	3,613	57	2379	11,886
BRENNEGAN-PRESTON		1,475	1,906	166	1	4014	7,562
LAKE-SILVER-POPE		92	61	5,039	6416	3003	14,611
NORTH FORK ENTIAT		7	1	9,688	2562	5358	17,616
THREE-TOMMY		203	49	8,806	1536	1959	12,553
ROARING-TAMARACK		2,449	1,023	11,136	171	1512	16,291
MILLS-DINKLEMAN		1,505	1,065	4,796	0	266	7,632
LOWER MAD		5,289	5,327	4,014	14	3427	18,071
MIDDLE MAD		1,278	3,311	5,252	364	424	10,629
UPPER MAD		158	234	11,807	1746	2910	16,855
HEADWATERS MAD		19	47	8,868	2767	1148	12,849
NAVARRE COULEE		7,128	3,111	1,598	0	51	11,888
RIBBON MESA		8,327	1,785	785	0	0	10,897
SWAKANE-SPENCER-TENAS		21,351	2,106	6,663	0	1901	32,021
FPU Wide	1,268						1,268
TOTALS		73,647	56,012	119,177	21,002	51,980	323,086

Figure E-1.3 **Percentage of Entiat Analysis Area by Vegetation Type.**

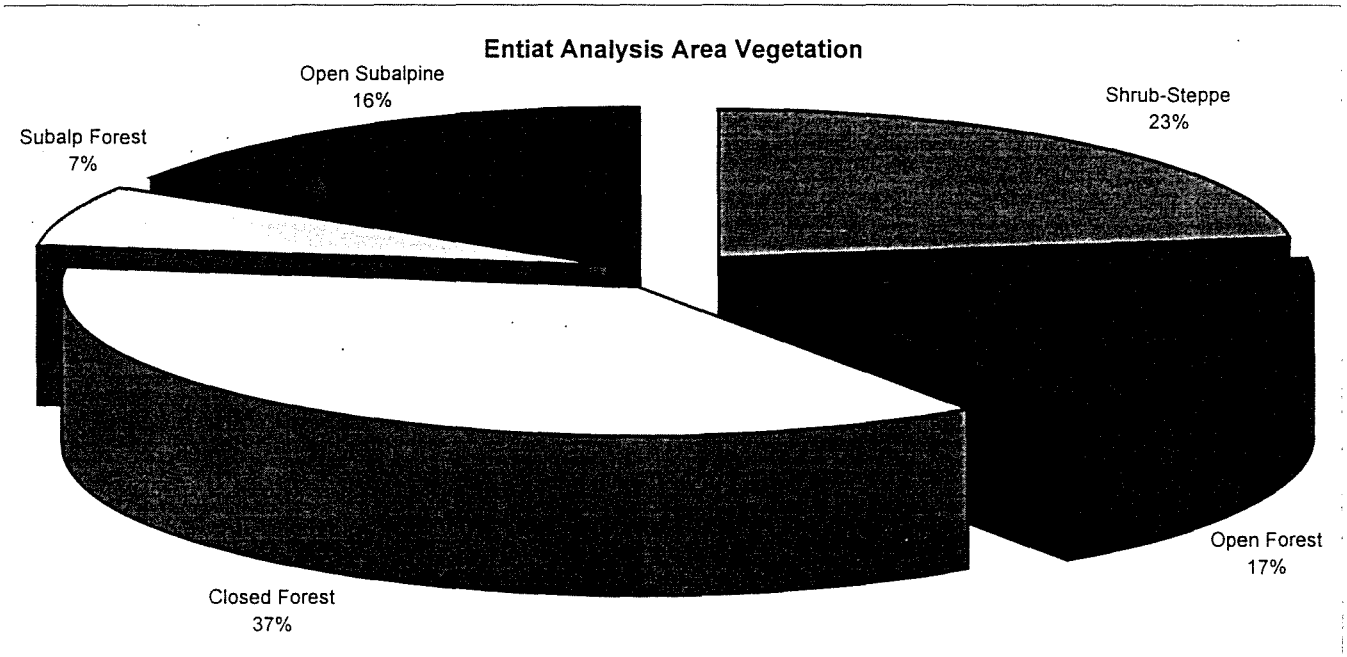
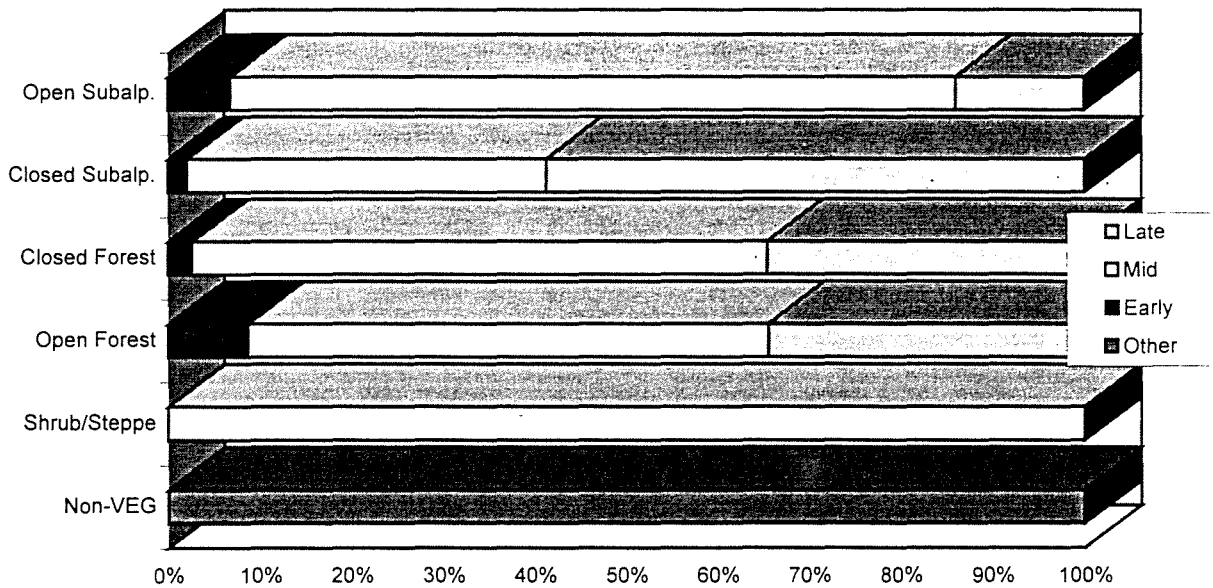


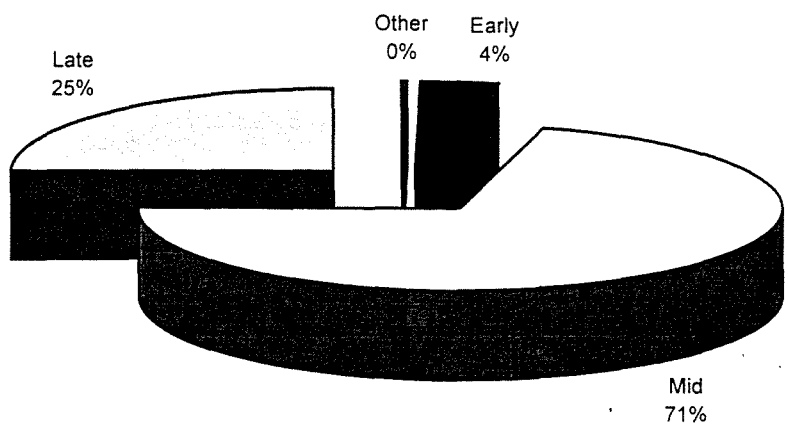
Table E-1.4 **Acres by Successional Stage by Vegetation Type - Pre-Fire.** Compilation of pre-Fire (1986) acres in Entiat Analysis Area by successional stage. Includes two figures illustrating distribution by percentage of vegetation groups by successional stage (pre-Tyee and Dinkleman Fires, 1986).

SERAL STAGE	VEGETATION ZONE--1986						
	Non-VEG	Shrub/Steppe	Open Forest	Closed Forest	Closed Subalp.	Open Subalp.	TOTAL
Other	1268						1268
Early			4846	3091	435	3524	11896
Mid		73647	31838	74804	8225	41172	229686
Late		0	19328	41282	12342	7284	80236
TOTAL	1268	73647	56012	119177	21002	51980	323086

ENTIAT ANALYSIS VEG GROUPS SUCCESSIONAL STAGES 1986



ENTIAT ANALYSIS AREA SUCCESSIONAL STAGES



Appendices E-1.5 through E-1.7

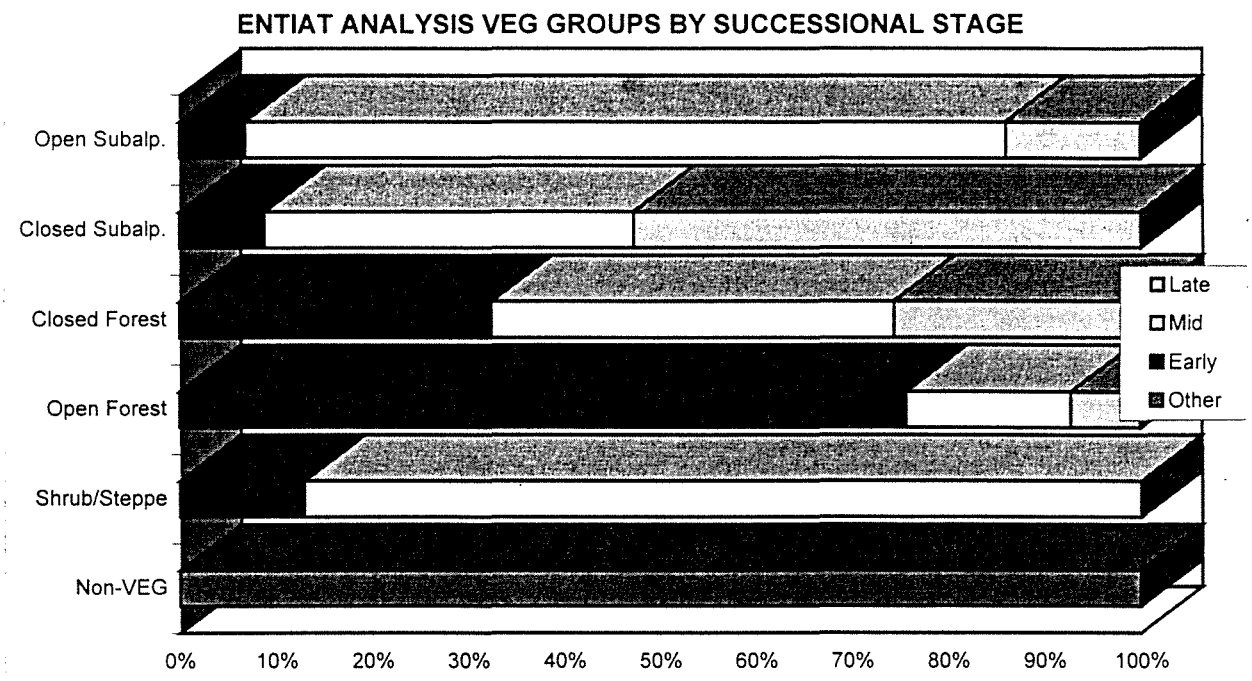
The following post-Tyee Fire vegetation charts were adjusted both within the Tyee Creek Fire and the 1988 Dinkleman Fire. In the Tyee Fire, areas shown on the fire effects map as severe (black) or moderate (brown) fire intensity were assumed to have moved back to an early successional condition. The post-Fire vegetation acres were then derived by overlaying the high and moderate fire effects areas with pre-Fire areas that were classified as mid- or late successional.

In the hot (black) burn areas, the successional stage has clearly moved back to early. Mortality of mature trees in the moderate burn areas is highly variable;therefore, in these less-intensely burned areas, the successional stage may have been only partially set back. Further ground mapping will verify actual site conditions, as future projects are implemented.

In the Dinkleman Fire Area, adjustments were based on knowledge of salvage logged areas and aerial photo interpretation. Since salvage primarily occurred in stands with near complete mortality, those acres had clearly reverted to an early successional stage.

Table E-1.5 **Acres by Successional Stage by Vegetation Type - Post-Fire.** Compilation of post-Fire (1995) acres in Entiat Analysis Area by successional stage. Includes two figures illustrating distribution by percentage of vegetation groups by successional stage (post-Fire).

SERAL STAGE	VEGETATION ZONE--1995						
	Non-VEG	Shrub/Steppe	Open Forest	Closed Forest	Closed Subalp.	Open Subalp	TOTAL
Other	1268						1268
Early		9489	42372	38628	1846	3531	95866
Mid		64158	9569	49977	8071	41172	172947
Late		0	4071	30572	11085	7277	53005
TOTAL	1268	73647	56012	119177	21002	51980	323086



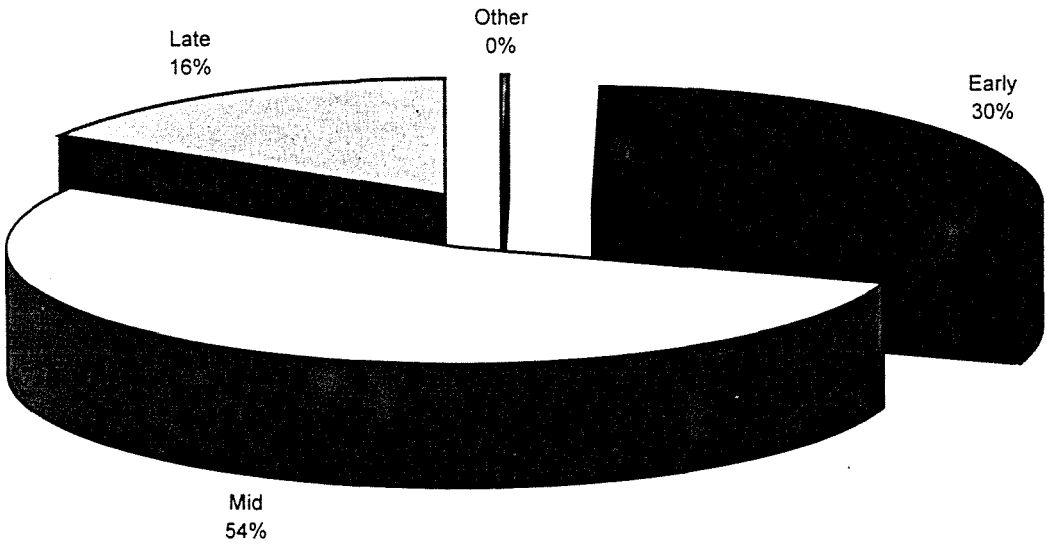
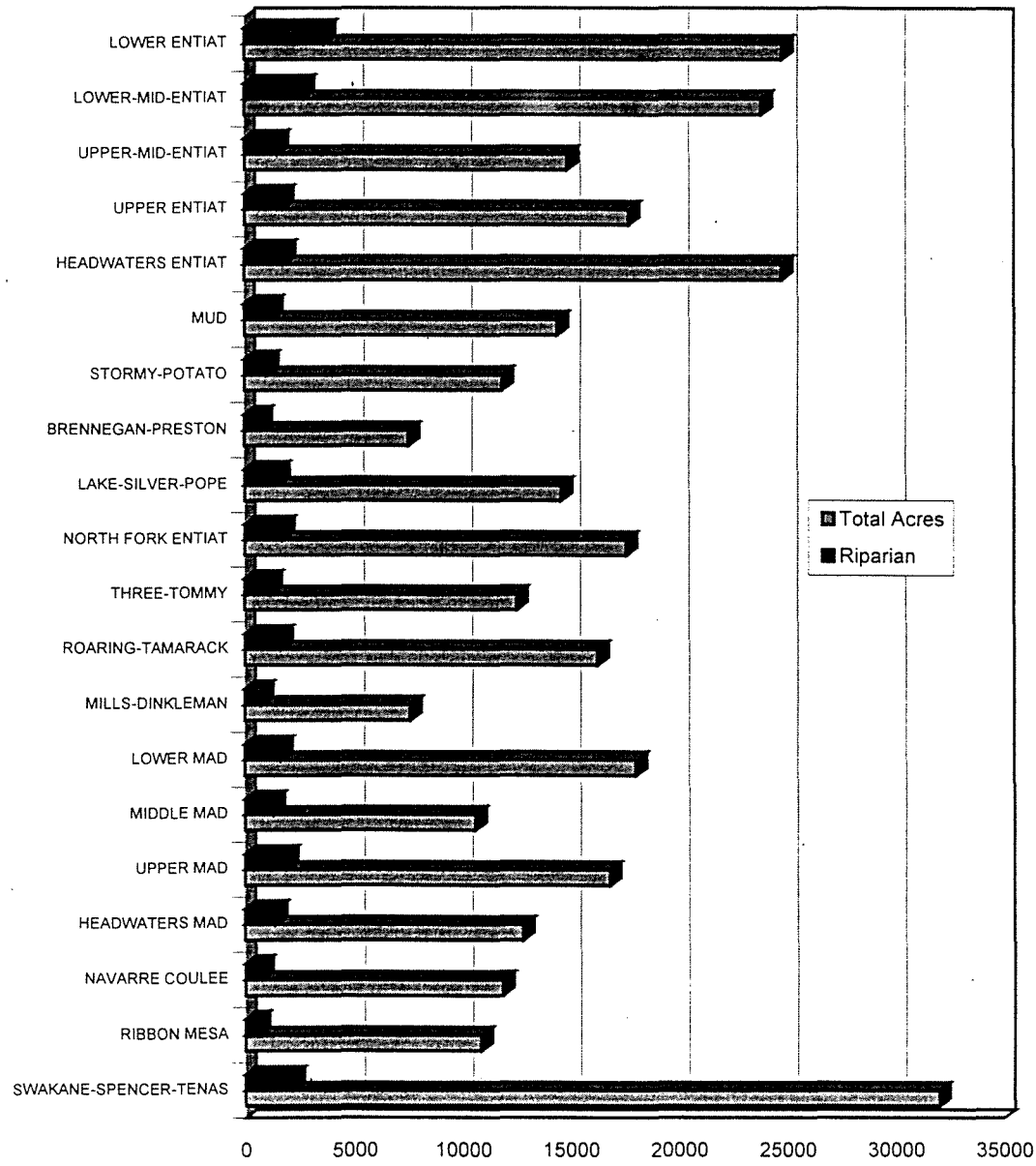


Table E-1.6 **Riparian and Total Acreage by FPU.** Total, riparian and burned riparian acreage by FPU for the Entiat Analysis Area (riparian burned acres not adjusted for 1988 Dinkleman Fire).

FPU NAME	Non-VEG	Total Acres	Riparian	Burned Riparian
LOWER ENTIAT		24,794	3,705	445
LOWER-MID-ENTIAT		23,856	2,737	1,889
UPPER-MID-ENTIAT		14,881	1,545	-
UPPER ENTIAT		17,731	1,759	-
HEADWATERS ENTIAT		24,774	1,854	-
MUD		14,421	1,284	1,002
STORMY-POTATO		11,886	1,060	827
BRENNEGAN-PRESTON		7,562	781	23
LAKE-SILVER-POPE		14,611	1,580	-
NORTH FORK ENTIAT		17,616	1,783	-
THREE-TOMMY		12,553	1,212	-
ROARING-TAMARACK		16,291	1,698	1,189
MILLS-DINKLEMAN		7,632	808	727
LOWER MAD		18,071	1,697	204
MIDDLE MAD		10,629	1,329	917
UPPER MAD		16,855	1,926	770
HEADWATERS MAD		12,849	1,439	29
NAVARRE COULEE		11,888	784	440
RIBBON MESA		10,897	619	185
SWAKANE-SPENCER-TENAS		32,021	2,215	-
FPU Wide	1,268	1,268		
TOTALS		323,086	31,815	8,647

Figure E-1.7 **Total and Riparian Acreage for the Entiat Analysis Area by FPU.** Shows estimates for total and riparian acreage by FPU, throughout all vegetation types (riparian burned acres not adjusted for 1988 Dinkleman Fire).



Appendix E-2

Species of Concern

EXOTIC PLANTS

Introduction

Exotic Plants are those non-native plants which colonize disturbed habitats or invade undisturbed native plant communities and may have deleterious effects on native plants and wildlife (Harrod et al. in press [b]). Many weeds are very persistent and may displace native species indefinitely. Daubenmire (1975) documented the continued dominance of *Bromus tectorum* (cheatgrass), *Descurainia* spp. (tansy mustards) and *Erodium cicutarium* (filaree) in a previously cultivated field, 50 years after it was abandoned.

The primary objective of ecosystem mangagement philosophy is to sustain the integrity of ecosystems, including their function, composition and structure. Managing and controlling exotic plants is important for the maintainence of vegetation structure and species biodiversity. The introduction of exotic plants can result in the alteration of plant and animal communities and their inter-relationships. The third greatest cause of plant species extinction world-wide is the spread of alien weeds (Society for Conservation Biology as cited by Lankford 1994). Like many areas that have experienced human activity, the Entiat analysis area has a number of weed species that are increasing their range at alarming rates.

Existing Condition

The roads on the Entiat drainage were surveyed in 1992 (McRae and Harrod 1992). Most notable and widespread are *Bromus tectorum* (cheatgrass), *Centaurea diffusa* (diffuse knapweed) and *Chrysanthemum leucanthimum* (oxeye daisy). *Linnaria dalmatica* (dalmation toadflax), is a highly-invasive weed that is found in the Tommy creek drainage. Other species known to occur within the Entiat analysis area are *Centaurea solstitialis* (Yellowstar thistle), *Cirsium arvense* (Canada thistle), *Cardaria draba* (whitetop), *Tanacetum vulgare* (common tansy), *Cystius scoparius* (scotch broom), *Hypericum perforatum* (St. Johnswort), *Verbascum thaspis* (wooly mullien), and *Rubus discolor* (Himalayan blackberry).

The lower Mud Creek area has extensive stands of knapweed, and in some areas, the native species are almost entirely absent. Not only have native plants been displaced, but this species reduces the quality of wildlife habitat, as it is nonpalatable. Areas with vast expanses of knapweed include Crum Canyon, Mud Creek, Potato Creek, Mill Creek and Tillicum Creek.

Cheatgrass is widespread in most lower elevation open environments and thus is common throughout the shrub/steppe and open Douglas-fir/ponderosa pine groups. It has taken over large expanses of what was historically bunchgrass. Being an early germinating annual, it can emerge before native species and effectively reduce available soil moisture before the native grasses germinate. Further, in stands dominated by cheatgrass, the dry herbage becomes a fire hazard in the summer.

The Tyee Fire burned over large areas infested with cheatgrass and knapweed. The burned area is extremely vulnerable to further spread of weeds, as native vegetation has been killed or is stressed and will need time to recover. Any ground-disturbing activities will seriously exacerbate the weed spread potential.

Historic Conditions

Prior to European settlement, the exotic species inventoried were not present within the analysis area. The invasion of these highly competitive species are causing a loss of vegetation structure and species diversity, in both forested and non-forested communities, which results in diminished ecological function. Successional processes may be disrupted by the replacement of native early successional species with non-natives (Harrod et al. in press [a]). This imbalance is detrimental to ecosystem structure, composition, function and process.

RARE SPECIES

Introduction

Rare species are important and add to the species diversity of the Entiat analysis area. From an ecological perspective, little is known about the role that rare species may play in the complex interrelationships of an ecosystem. They may be a step in diversification that promotes viability of a species group (Harrod et al. in press [a]). Also, rare plant species may be important for other rare species, such as a rare insect pollinator.

Existing conditions

The Entiat analysis area has a variety of habitats that could be occupied by rare plants. The chart in Appendix E-3 lists those species which occur or are suspected to occur within the analysis area and the suspected potential habitat.

There are seven rare plant species known to occur within the Entiat analysis area. *Trifolium thompsonii* (Thompson's clover), *Petrophyton cinerascens* (Chelan rockmat), *Iliamna longisepala* (longsepal globemallow), *Hackelia hispida* var. *disjuncta* (rough stickseed), *Astragalus arrectus* (Palouse milk-vetch), *Chaenactis thompsonnii* (Thompson's chaenactis and *Carex buxbaumii* (Buxbaum's sedge). All of these species are listed as Sensitive by the Regional Forester and both *T. thompsonii* and *P. cinerascens* are category 1 Federal candidates as well. The general location of these species are [Swakane Canyon area for *T. thompsonii* and *A. arrectus*, cliffs of the Columbia breaks for *P. cinerascens*, Mad River, Tillicum and Potato Creeks for *I. longisepala*, Potato Creek for *H. hispida* var. *disjuncta*, Mills Canyon area for *C.thompsonnii* and Lake Creek area for *C. buxbaumii*. Specific locations are on file at the Entiat Ranger Station.

T. thompsonii typically occurs in shrub/steppe and open forest. This species increased after the Dinkleman Fire, but is not known from the Tyee Fire area. *P. cinerascens* is a crevice dweller--often found on sheer cliffs. It is very abundant where it occurs, but its range is extremely limited. Populations of *I. longisepala* occur within a variety of habitat types, including: grass/shrub steppe, and open pondersoa pine and/or Douglas-fir. Most of the more extensive populations occur in a non-forested to open forest setting. However, there are some populations with just a few individual plants in closed canopy Douglas-fir and/or ponderosa pine forest. This species has increased in number after fire disturbance, and appears to be stimulated to germinate following fire. *H. hispida* var. *disjuncta* is found at the base of talus slopes with little other vegetation present. *Chaenactis thompsonnii* prefers dry, relatively barren ravelly slopes and *A. arrectis* is typically found in shrub/steppe. *C. buxbaumii* is found within bogs and marshes.

Relatively little of the total analysis area has been surveyed for rare plants. There is no way of knowing a detailed distribution of rare plants within the drainage.

The Tyee Fire of 1994 burned 88,959 acres of analysis area lands. Since the rare species of this area evolved with and are likely adapted to fire, the fire itself could have little negative impact, and a possible beneficial effect for early successional species and species dependent on fire for seed germination. If one follows the logic that this fire was not a "natural" fire (due to past fire suppression resulting in high fuel loading and greater fire intensity), then the fire could have a negative impact on rare plant populations. This would occur by altering plant habitats that would not have burned so hotly under natural fire conditions and possibly destroying viable seed within the seed bank. A significant factor that could affect rare plants and their habitat is the spread of noxious weeds to areas that were disturbed during fire fighting efforts, or that will be disturbed during post-fire activities.

Currently, there are two active grazing allotments within the drainage. Much of the allotment lands burned over in the Tyee Fire, and grazing activities in these areas have been halted for the immediate future.

Historic Condition

Little is known about the biology and ecology of the plants listed above. Modes of reproduction, response to disturbance, interactions with other species and genetic variability need to be studied. Such studies could help to reconstruct historic distribution and abundance of rare plant species. A real challenge in any holistic study is to determine if species populations increase or decline is a result of management activities or natural phenomena.

One can speculate, however, that some rare plant species may have been more abundant given that these species likely evolved in a fire regime. Now that fire frequency and extent have been significantly altered, one might conclude that rare plant populations and distributions have also been altered.

Appendix E-2.1

SENSITIVE PLANTS BY HABITAT

Mixed Deciduous and Coniferous Forests

Botrychium lanceolatum
Botrychium lanceolatum
Botrychium montanum
Botrychium pinnatum
Cypripedium (***calceolus*** var.) ***parviflorum*** (damp, mossy, mised forest)
Montia diffusa

Moist to Dry Coniferous Forests

Antennaria parvifolia **(open ponderosa pine)**
Astragalus arrectus (open pine)
Botrychium lanceolatum
Botrychium lunaria
Botrychium minganense (often with western red cedar)
Botrychium montanum
Botrychium pinnatum
Cypridpedium fasciculatum
Iliamna longisepala (open ponderosa pine or mixed conifer)
Montia diffusa
Orobanche pinorum (parasitic on oceanspray)
Pellaea brachyptera
Pleuricosppora fimbriolata (emerging from the duff in dense forest)
Sidalcea oregana var. ***calva***
Trifolium thompsonii

Serpentine Soils

Chaenactis thompsonii
Geum rossii var. ***depressum***

High Elevation Open Ridgetops

Anemone nuttalliana
Botrychium pinnatum

Rock Outcrops and Crevice/Cliffs/Ledges

Saxifraga debilis
Cryptogramm stelleri (shaded, moist and limestone cliffs)
Pellaea breweri
Petrophytun cinerascens

Gravel/Scree/Talus/Other Rocky Areas

Botrychium lancelolatum
Botrychium minganense
Carex proposita (often on talus)
Geum rossii var. ***depressum***
Hackelia hispida var. ***disjuncta***
Hackelia venusta (rocky slopes, sometimes with ponderosa pine)
Saxifraga debilis

Eritrichium nanum var. ***elongatum***

Dry Meadows

Agoseris elata
Anemone nuttalliana
Astragalus arrectus
Castilleja cryptantha
Delphinium viridescens (moist meadow, drying in summer)
Githopsis specularoides (dry, open places)
Iliamna longisepala
Mimulus suksdorfii
Nicotianna attenuata
Oryzopsis hendersonii
Pedicularis rainierensis
Trifolium thompsonnii (to lightly wooded)
Silene seelyi

WET MEADOWS/MARSHY AREAS/SEEPS/OTHER RIPARIAN AREAS

Botrychium lunaria
Botrychium pinnatum
Botrychium simplex
Carex buxbaumii (bogs, marshes, wet meadows)
Carex comosa (marshes, lake margins and ditches)
Carex macrochaeta (seeps and waterfall areas)
Carex paupercula (bogs and sedge meadows)
Carex saxatilis var. ***major*** (shallow water, bogs and sedge meadows)
Carex stylosa (marshes and streambanks)
Carex synchocephala (marshes, lake margins)
Castilleja cryptantha (subalpine meadows)
Cicuta bulbifera
Cypripedium (***calceolus*** var.) ***parviflorum***
Delphinium viridescens (meadow drying in summer)
Elocharis atropurpea
Epipactis gigantea (streambanks, lake margins, wet spots in dry places)
Iliamna longisepala (gravelly streambanks)
Loiseleuria procumbens
Pedicularis rainierensis
Plantanthera sparsiflora
Salix vestita var. ***erecta*** (high elevation)
Saxifraga debilis
Sidalcea oregana var. ***calva*** (streambanks, boggy meadows)
Spiranthes (***romanzoffiana*** var.) ***porrifolia***

Appendix F
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Soil/Water/Fish

Page

Executive Summary (Refer to SWF Analysis Summary in Chapter 2, Page 28)

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Appendix F

Soil, Water & Fish Analysis
Entiat Analysis Area

Executive Summary: Refer to the SWF Analysis Summary in Chapter 2 of this document.

Appendix F-1

I. Identify Issues, Discuss Preliminary Desired Ecological Condition, & Formulate Key Questions

PURPOSE
Focus on the key issues and questions that will direct the analysis and define, in preliminary terms, the desired conditions of the watershed related to these issues. The following three issues were a primary focus of this analysis. Additional key questions related to the Version 2.0 emphasis issues are summarized in Chapter 1 of the watershed assessment.

KEY ISSUE - A. Sedimentation (WA Question #6)

Sedimentation resulting from fire disturbance and long-term fire recovery efforts can affect beneficial uses of the water resource including water quality, irrigation, anadromous and bull trout fish habitat in the Entiat subbasin.

Key Questions:
* What is the current sediment yield of the subbasin?
* How does current sedimentation compare with presettlement rates?
* Where and why is there a difference between current and presettlement sedimentation?
* How can long-term fire recovery protect stream systems and aquatic habitat?

KEY ISSUE - B. Aquatic Habitat (WA Question #13)

Aquatic habitat simplification resulting from human activities, fire/flood disturbance, and past rehabilitation efforts affects anadromous and resident fish populations in the Entiat subbasin.

Key Questions:
* What is the current condition of aquatic habitat?
* How does current aquatic habitat compare with the range of habitat conditions that the aquatic species evolved with?

* Where and why is there a difference between current and presettlement aquatic habitat?
* How can long-term fire recovery protect stream systems and aquatic habitat?

KEY ISSUE - C. Watershed Rehabilitation (WA Question #10)

Watershed improvement work in the Entiat subbasin needs to be targeted at high-priority problem areas.

Key Questions:

* Where and what type of watershed improvement work should be accomplished in the Entiat subbasin over the next two years?
* Within the Tyee Complex Fire, where should BAER work be supplemented or enhanced?
* How can other long-term fire recovery efforts support these watershed improvement efforts?

Preliminary Description of Desired Ecological Conditions

Overall Goal

The Entiat Analysis Area, including hillslopes, riparian zones and stream channels, should be in a state of dynamic equilibrium such that these watershed components function properly, are stable and are resilient to a range of natural events.

A. **Hillslopes** should be vegetated and soils which have been disturbed due to compaction allowed to recover in order to handle water at the potential infiltration and percolation rates. Erosion and sediment delivery should be within the same range of natural variability as presettlement rates for similar landform development processes.

B. **Riparian zones** should function as floodplains by dissipating energy, trapping sediment, buffering hill slope processes, providing shade, contributing vegetative materials to the stream channel, yielding slow release streamflow and promoting natural nutrient cycling.

C. **Stream channels** should be unconstrained and able to move laterally across riparian zones without aggrading or degrading the overall longitudinal profile. Stream channels should exhibit a shape and form typical for the physical and climatic characteristics of the analysis area.

D. The genetic variability and viability of the remaining native **fish stocks** should be maintained. Spawning, rearing and holding habitats should be protected.

Appendix F-2

II. Identify Key Processes, Functions & Conditions

PURPOSE
Identify the primary processes influencing the key resource issues or the ability of the analysis area to attain desired conditions.

EROSION, SEDIMENT AND SEDIMENT DELIVERY
Soils in the Entiat subbasin are very erodible. Most landtypes have high sediment delivery rates. The amount and size of sediment delivered to and deposited in stream channel substrate is directly related to geologic and landtype features which vary throughout the subbasin. In the upper subbasin glacial troughs produce coarse sediments whereas in the lower subbasin unglaciated mountain slopes produce fine sediment.

Disturbance regimes can alter the sedimentation rate and the delivery of sediment from hill slopes to riparian and stream systems. These disturbances can be natural or human-caused. The desired condition is a balanced sedimentation regime, stable over the long-term, and a watershed system that can respond with resiliency to disturbance.

Flooding is a phenomenon that has occurred historically following fire disturbance. The triggering mechanisms have included convective storms, rain-on-snow events, and rapid melt of the snowpack. Whether the frequency and intensity of rain storm events have been affected by microclimatic factors altered by fire disturbance is unclear but has been hypothesized.

The immediate goal given the magnitude of fire disturbance that occurred in 1994 is to accomplish vegetative recovery in the burn area. This is in addition to assessing the cumulative effects of fire disturbance and past management on watershed processes on hillslopes, riparian zones, stream systems and aquatic habitat within the entire subbasin, identifying desired future condition for those processes.

SOIL PRODUCTIVITY
It is suspected that soil conditions were altered during the turn of the century by grazing activities. According to historic grazing records, the level of grazing would have drastically reduced stocking of understory grasses and low lying shrubs.

The effects of this historic grazing are thought to influence important processes in the Entiat analysis area. With the removal of vegetative cover, surface erosion would have been greatly accelerated (Plummer et al. 1902). Grazing increases soil compaction and decreases infiltration (Bohn and Buckhouse 1985). These combine to increase surface runoff and erosion and decrease root growth and aeration. Surface soils in the watershed generally contain a very erodible volcanic ash. This ash layer is very important in soil moisture and nutrient availability. Reduced infiltration and the loss of this volcanic ash layer due to compaction and surface erosion could drastically affect available moisture for shallow rooted grass species.

Within the ponderosa pine and Douglas-fir zones, the drastic reduction in understory grasses would have created conditions favorable for the establishment of coniferous seedlings. Kingery and Graham (1990) found that persistent grazing may increase tree growth by removing understory competition but that this effect may be temporary as soil fertility is reduced with continued grazing (Irwin et.al. 1994). Due to the decline in grazing coupled with an increase in fire suppression from the early 1930's to present, these new tree seedlings would have survived. The overall effect would be an increase in coniferous vegetation and a decrease in grassy understories.

The combined change in tree stocking is strongly linked to historic grazing and fire suppression. Hence, the historic open park like stands of mature coniferous trees associated with relatively dense grassy understories have been converted to more even-aged forest stands with sparse understories consisting of few perennial bunchgrasses. The ability of the affected south slope areas to support a vigorous understory grass community similar to historic conditions is in question.

SOIL MOISTURE STRESS

Climatic conditions coupled with coarse textured soils create conditions which limit soil moisture, particularly in the depositional zone (LTA E). Erosion and/or compaction of the finer textured soils at the surface further reduces available soil moisture capacity. Areas of the Entiat Analysis Area are on the lower elevation or outside the range of coniferous vegetation. Moisture availability is typically the limiting factor to vegetative growth. In many areas, existing vegetative stand structure is much denser than historic conditions and exacerbates moisture stress. This increase in fuel loading coupled with severe drought conditions contributed to the severity of 1994 wildfires.

Moisture stress will strongly influence immediate and long-term vegetative recovery following a major disturbance like fire. Consumption of organic matter by fire causes an increase in soil temperature and evaporation and accelerates decomposition of the remaining soil organic matter (Childs et.al. 1989). Mineral soil is exposed to the impacts of rain which results in breakdown of aggragates at the surface. This can lead to an increase in surface sealing which decreases infiltration and increases erosion by water (Karlen and Stott 1994). A decline in the root network either through fire loss or compaction reduces macropores and other channels for water entry. Erosion and/or compaction of these soils magnify the effects of moisture stress common to the low and mid-elevation mountains in the eastern portion of the Entiat watershed and the Columbia River Breaks areas.

RIPARIAN FUNCTION ALTERATION

Riparian functions include stream shading, nutrient cycling, sediment buffering, large woody debris recruitment, bank stability, watershed storage capacity, flood energy dissipation, and habitat for certain wildlife species. These functions vary naturally depending on the successional stage of riparian vegetation. The riparian zones in the private lands along the lower half of the Entiat River have been recovering from major fire/flood events in 1970/1972/1974, 1976/1977 and 1988/1989. Concurrently, riparian zone function and process have been restricted by road building, channelization, logging, and land clearing for dwelling, recreation, agriculture, and livestock. As a result, riparian function has been detrimentally altered.

CHANNEL FUNCTION ALTERATION

As riparian function has been altered, so has channel function. In response to flooding, several episodes of channelization and stream cleanout have occurred in the lower half of the Entiat River. This has contributed to the reduction in potential and acting large woody debris (LWD), the loss of off-channel and side channel habitat, and habitat simplification. All of these factors plus excessive fine sediment probably limit macroinvertebrates, anadromous spawning, and juvenile rearing in the most productive portions of the Entiat River (the lower mid-Entiat), a predominantly depositional reach.

ANALYSIS ELEMENTS NEEDED TO EVALUATE KEY PROCESSES

In order to assess the significance of various perturbations on the above listed key ecosystem processes, functions and conditions, certain analysis elements were identified for evaluation. The elements are listed as follows.

Percent of Fine Sediments in Stream Substrate

Dominant Landtype Association (LTA)

Average Annual Precipitation (inches)

Precipitation Type

Dominant Vegetative Plant Association

Burn Intensity of 1994 Wildfires

Nature and Amount of Historic Range Forage Utilization

Stream Density

Miles of Road Within 300 Feet of Stream Channels

Alluvial Fans

Road Density (miles road per square mile)

Large Woody Debris in Stream Channel Reaches

Number of Pools in Stream Channel Reaches

The first two of these analysis elements, percent of fine sediment in stream channels and landtype association were judged to be key in spatially defining the condition of ecosystem processes and functions within the analysis area. They were used as the basis for stratification of the analysis area.

Appendix F-3

III. Stratify the Watershed

PURPOSE

Stratify the analysis area into units that are relatively similar in regards to ecosystem function, process and condition.

The Entiat Analysis Area was stratified into three zones using two criteria: percent fine sediment in substrate gravels and landtype association. Percent fines of in-gravel sediment was selected as a criterion because of the importance of the sedimentation issue. Percent fines is a measure of both current condition and of cumulative impacts on the stream channel system and aquatic habitat. The three zones were also related to the vegetation zones used by all resources in the watershed analysis.

A general description and history of the Entiat Analysis Area can be found in the text and Appendix C of the watershed assessment. Appendix VI provides information on climate and runoff for the Entiat.

PERCENT FINE SEDIMENT IN STREAM SUBSTRATE

All Fish Production Units (FPU's) within the Entiat Analysis Area were rated for fine sediment based on three evaluations: percent fines in mainstem Entiat River and Mad River as measured by core sampling; visual evaluation of the level of embeddedness determined as part of stream survey; and professional judgement based on knowledge of field conditions.

FPU's were placed in one of three categories depending on a comparison of fine sediment in the subwatershed with current forest plan standard for percent substrate fines. Numeric criteria are as follows:

Red = >20 percent fine sediment (Current plan standard is 20 percent).
Yellow = 15 to 20 percent fine sediment.
Green = <15 percent fine sediment.

LANDTYPE ASSOCIATIONS

The landtype associations (LTAs) used in the stratification were identified through a mapping effort in 1992 via a contract by Herb Holdorf retired R-1 Regional Soil Scientist. The Soil Resource Inventory (McColley 1976) for the Wenatchee NF was the primary building block for the identification of Landtype Associations. There are five LTA's mapped for the Entiat Analysis Area.

Three general groupings of LTA's were identified for this analysis. LTA's were used to define sediment delivery and sediment loading. The LTA's were grouped to represent the settings in the upper Entiat, mid Entiat, and lower Entiat. These landtype Associations are described in detail in the document Wenatchee Landtype Associations Map Unit Descriptions and is not contained in this document.

The **upper Entiat** watershed represents a zone where fine sediment is in transport with minimal deposition. The **mid-Entiat** watershed represents a zone where fine sediment is in transition of both transport and deposition. The **lower Entiat** represents a zone where fine sediment is accumulating, with high intensity storms being a primary transport mechanism. Debris flows typically increase following fires.

LTA's of the **upper Entiat** subbasin consist of Glacial Cirques and Glacial Troughs. These LTA's are listed as A and B in the analysis tables in Section IV. This combination of LTAs create typical U-shaped valleys. These high elevation landforms generally contain very steep, barren slopes in the upper elevations and thick mantles of glacial till in the lower elevations. These landtypes have high sediment delivery associated with coarse textured sediment. Usually sediment is delivered through debris slides that occur periodically as pulses, largely triggered by rain-on-snow events. The sediment is derived from glacial till deposits which are comprised of coarse sub-rounded to rounded gravels, cobbles, and boulders. These till deposits form a mantle on mid to lower slopes of Glacial troughs. The till was derived from hard crystalline igneous and metamorphic bedrock. The larger materials in this till do not tend to decompose rapidly into finer particle sizes through stream bed scouring. Stream survey data indicate that finer sediments delivered to the channel during events are typically transported due to stream velocity, with minimal deposition.

LTA's in the **middle Entiat** subbasin consist of glaciated mountain slopes that did not develop into a U-shaped trough. These LTA's are indexed as C in the analysis tables listed in Section IV. Streams have deeply incised, V-shaped tributary valleys. Upper slopes are less steep and do not have the stream density to create high sediment delivery conditions. Sediment would be derived from glacial till and pumice/ash deposits. This LTA is transitional in fine sediment transport and deposition according to stream survey information.

The dominant LTA in the **lower Entiat** subbasin and the adjacent Columbia River Tributaries is characterized by hilly, low elevation mountains which have been dissected by dense, dendritic drainage patterns. These LTA's are indexed as E in the analysis tables listed in Section IV. This area is composed of old land surfaces composed of highly weathered granitic gneissic and schistic bedrock which is highly erodible. These surfaces have high sediment delivery associated with fine sediment "sand size particles". Sediment is derived from volcanic ash, pumice, and "sandy" residuum from weathered bedrock. Due to steep slopes, high drainage density and highly erodible soils, available sediment is readily transported to drainage bottoms where it is stored between "flushing" events. All tributary draws have developed alluvial fans. These fans provide vast quantities of sediment during flood periods, especially following large fires.

STRATIFICATION ZONES

The resulting three zones of stratification are identified as:

1) Predominantly Sediment Transporting,
2) Predominantly Sediment Depositional; and
3) Transitional Zone between Zones 1 and 2.

The Entiat Analysis Area is within the Eastern Washington Cascades province. The Entiat can be divided into three watersheds: (1) the Entiat River, (2) the Mad River, and (3) minor Columbia River tributaries from Swakane Canyon to Navarre Coulee. These watersheds were divided into twenty subwatersheds for purposes of this analysis. The Wenatchee Forest Land Management Plan (1990) uses the terminology "fish production units" (FPU's) for these subwatersheds.

That terminology will be used throughout this analysis. Based on the above stratification these twenty subwatersheds (FPU's) fall into one of the three zones as follows.

Subwatersheds (FPUs) in the Entiat Analysis Area Grouped by Stratification (Figure F-3.1)

Sediment Transport Zone	Sediment Depositional Zone	Transitional Zone
Upper Entiat	Lower Entiat	Upper Mid-Entiat
Headwaters Entiat	Lower Mid-Entiat	Lake-Silver-Pope
North Fork Entiat	Mud Creek	Middle Mad
Three Creek-Tommy	Stormy-Potato	Upper Mad
Headwaters Mad	Roaring-Tamarack	Brennegan-Preston
	Mills-Dinkleman	
	Lower Mad	
	Swakane-Spencer	
	Ribbon Mesa	
	Navarre Coulee	

The analysis that follows talks specifically to conditions within each of the three zones or within their twenty FPUs.

Preliminary mapping indicates that historic vegetative patterns reflect potential vegetative patterns derived from soil type interpretations.

The three landtype/sediment transport zones were also related to the vegetation groups used by all resources in the watershed analysis. The crosswalk between the two stratifications is shown below. Exact delineations between the strata are not possible, as indicated by the occurrence of closed, sub-alpine forest in both the transport and transitional zones; however, the comparison is adequate for meaningful analysis at the watershed level.

Landtype Sediment Transport Zone	Dominant Vegetative Groups
Transport Zone	Subalpine Closed Subalpine Forest
Transitional Zone	Closed Subalpine Forest Closed Forest
Depositional Zone	Open Forest Shrub/Steppe

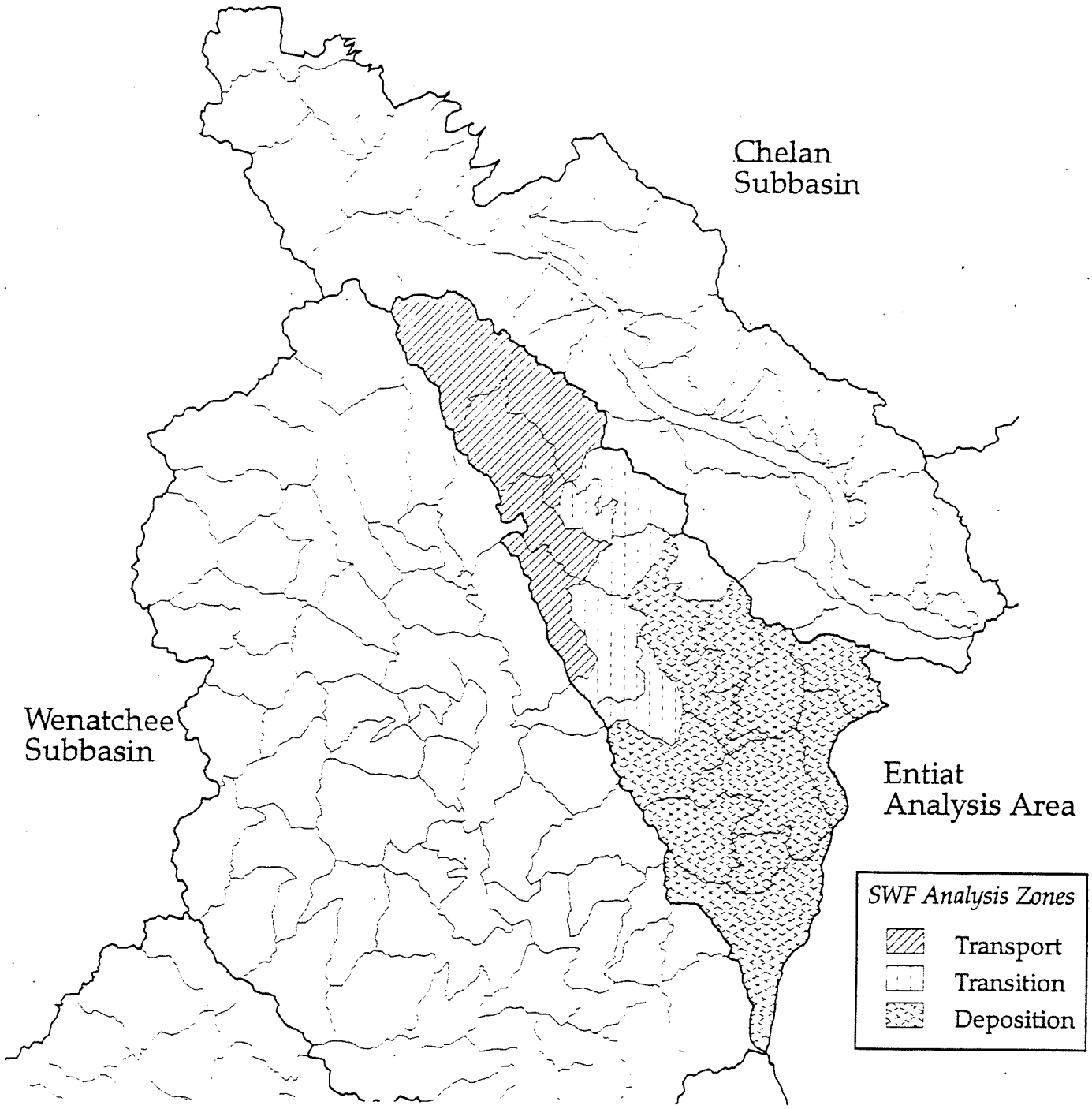


Figure F-3.1 **Transport, Transitional and Depositional Zones.** Stratification of the Entiat Analysis Area.

Appendix F-4

IV. Assemble Analytic Information to Address Key Questions

PURPOSE
To characterize the three zones and FPU's by analysis elements. Each FPU within the Entiat Analysis Area was described by a number of analysis criteria. The criteria and abbreviations used in the following tables are listed as:

ANALYSIS ELEMENTS

Dominant Landtype Association (Dom LTA)

Major Stream Sedimentation Process (Transport or Depositional) (T or D)

Dominant Vegetative Type (Dom Veg)

Grazing Intensity (Grazd)

Percent of Fine Sediments in Stream Systems (Fines)

Slope Delivery Efficiency (Del)

Stream Density (Strm Den)

Acres of Alluvial Fan (Fan Ac)

Road Density; miles per square mile (Rd Den)

Roads (miles) within 300' of a channel (Riprn Rd)

Burn Intensity; % of FPU burned high and moderate in 1994 (B.I.)

Average Annual Precip; inches (Precip)

Total Area in Acres for each FPU (Area)

All FPU's were grouped by zone. Tables F-4.1-F4.3 display analysis element data for all FPU's within each zone. Further analysis will be on the basis of these zones. Please refer to Appendix III for definitions of data elements used in this analysis. Appendix F-9-I contains a summary of the stream survey data used to help characterize FPUs in this analysis (Table F-9-I-1).

Tables F4.1 to F4.3 Analysis Element Data for the SWF Zones in the Entiat Analysis Area.

FPU	Dom LTA	T or D	Dom Veg	Grazd	Fines	Del	Strm Den	Fan Ac	Rd Den	Rprn Rd	Bl	Precip	Area
Table F-4.1 - **TRANSPORT**													
Upper Entiat	A/B	T	GF	M	GRN	L	1.44	N/A	0.6	3.1	0	54	17,761
Headwaters Entiat	A/B	T	HI ELV	M	GRN	L	0.89	N/A	0	0	0	65	25,881
North Fork Entiat	A/B	T	HI ELV	M	GRN	L	1.05	N/A	0.8	1.2	0	60	17,643
Three Creeks-Tommy	C2/B	T	HI ELV	M	GRN	L	1.52	N/A	0.4	1.6	0	56	12,542
Headwaters Mad	C2	D	HI ELV	M	GRN	M	1.46	38	0.1	0.7	2	51	12,851
TOTAL AREA													86,678
Table F-4.2 - **TRANSITIONAL**													
Upper Mid-Entiat	A/B	T	DF	H	YEL	M	1.59	N/A	1.8	7.7	0	50	14,913
Lake-Silver-Pope	C2	T	HI ELV	M	YEL	H	1.61	N/A	2.1	7.5	0	57	14,611
Brennegan-Preston	C	T	DF	M	RED	H	1.74	198	6.6	13.0	3	52	7,559
Middle Mad	C/E	T	DF	M	YEL	M	1.87	186	3.8	8.6	69	34	10,628
Upper Mad	C2	T	GF	M	YEL	L	1.69	235	1.8	6.5	40	43	16,852
TOTAL AREA													64,563
Table F-4.3 - **DEPOSITIONAL**													
Swakane-Spencer	E	D	PP/GRAS	H	RED	H	1.72	N/A	1.4	17.4	0	15	32,070
Ribbon Mesa-Okla Gl	E	D	PP/GRAS	H	RED	H	1.54	N/A	1.7	6.0	38	10	10,884
Navarre Coulee	E/C	D	PP/GRAS	H	RED	H	1.68	N/A	2.5	15.9	41	18	11,944
Lower Entiat	E	D	PP/GRAS	H	RED	M	1.75	573	3.3	27.3	12	17	24,708
Lower Mid-Entiat	C/E	D	DF	H	RED	H	1.91	997	3.1	23.8	69	34	23,833
Mud Creek	E/C	D	PP	H	RED	H	2.0	562	3.7	36.2	78	25	14,427
Stormy-Potato	E/C	D	DF	H	RED	M	1.78	205	2.7	12.9	78	37	12,033
Roaring-Tamarack	E	T/D	GF	H	RED	H	1.83	N/A	4.5	23.9	0	32	16,294
Mills-Dinkleman	E	T/D	DF	H	RED	H	1.48	N/A	4.9	8.2	0	26	7,630
Lower Mad	E	T	PP/DF	H	RED	M	1.67	183	7.3	33.5	12	32	18,020
TOTAL AREA													171,843

FPU = Fish Production Unit
Dom LTA = Dominant Landtype Association
T or D = Transport or Depositional area
Dom Veg = Dominant Vegetation Type
Grazd = Grazing Intensity
Fines = Fine Sediment Deposition
Del = Slope Delivery Efficiency

Strm Den = Stream Density (miles/square mile)
Fan Ac = Acres of Alluvial Fan
Rd Den = Road Density (miles/square mile)
Riprn Rd = Miles of Road within 300' of Stream Channel
Bl = Percent of FPU burned at Moderate or High Intensity
Precip = Average Precipitation in Inches
Area = Area (acres)

LANDTYPE ASSOCIATION INTERPRETATIONS

Landtype associations (LTAs) were used to develop the following site interpretations: erosion hazard, debris slide hazard, sediment delivery hazard, soil compaction hazard, moisture stress, surface runoff, subsurface water storage, and regulation of stream flow. Table F-4.4 contains a listing of interpretations for these LTA's. The rationale for these interpretations is contained in the document, *Wenatchee National Forest Watershed Analysis Interpretation Guide 1994*. Due to map scale, a range of materials and conditions exist within each unit. The interpretation rating represents the dominant conditions within the LTA and not the full range. Ratings for dissimiliar inclusions within the unit are footnoted.

Table F-4.4
LANDTYPE ASSOCIATION INTERPRETATIONS

LTA Legend

LTA A: Glacial trough headwalls and cirque basins (Transport Zone).
LTA B1: Glacial troughs mantled by pumice (Transport Zone).
LTA C2: Glaciated mountain slopes mantled by volcanic ash and pumice (Transitional Zone).
LTA E: Mountain slopes underlain by granitics and gneiss (Deposition Zone).
LTA H: Stream Bottoms.

(Refer to LTA discussion in Section III for descriptions of LT setting)

WNF Landtype Association Interpretation Table

CLASS	HAZARD ELEMENT	A	B1	C2	E1	H
---	---	*1	---	---	---	---
1	Surface Erosion	M	H	M	H	M*2
1	Deep-seated Failure	L	L	L*4	M*4	L
1	Debris Slide	M	H	M*5	M*5	L
1	Sediment Delivery	M	H	M	H	H*2
1	Soil Compaction	L*3	M	M-H	H	H
2	Soil Moisture Stress	M*6	L	L*7	H	L
3	Surface Runoff	H*8	M	M	H	L
3	Subsurface Storage	L*9	H*10	M	L	M
3	Stream Flow Reg.	L*11	H	M	L	M
3	Stream Density *12	M	M	M	H	---

* See footnotes on following page.

The **first CLASS** of interpretations in Table 4 represents the **physical disturbance hazards**. A high ranking generally implies a severe level of occurrence, while a low ranking generally implies a slight level of occurrence and a moderate ranking somewhere in between the low and high. The erodible material characteristic of LTAs **A**, **B**, and **C** is coarse-textured Glacial till material (gravels and boulders) while LTA **E** is characterized by fine, sandy-textured materials.

The **second CLASS** of interpretations represents **vegetation growth influences**. High moisture stress generally implies adequate soil moisture is not available to support vigorous coniferous timber stands and, most often, sites can only support grassland/shrub communities. Low stress infers that adequate soil moisture is not limiting coniferous timber stands and generally excess soil moisture exists.

The **third CLASS** of interpretations relate to **hydrologic influences**. High surface runoff indicates that a high amount of precipitation runs off the ground surface and causes flashy stream flows. Moderate and low indicate that surface runoff is much less and stream flows are not usually flashy. High sub-surface water storage indicates that a tremendous amount of near surface ground water is stored on site and strongly influences late summer base flows, with seeps and springs are common. A low subsurface water storage indicates that little moisture is stored on site and few seeps or springs occur across the landscape. LTA **E** is characterized by intermittent and interrupted stream flows in the eastern portion of the Entiat River.

The landtype association groups correspond very well to the general vegetation groups used in the analysis of the Entiat Watershed. Listed below are the LTA linkages to the general vegetation groups identified for the Entiat Watershed:

1. LTA **A** supports **subalpine** group
2. LTA **B** supports **closed subalpine** group
3. LTA **C** supports **closed forest** group
4. LTA **E** supports **open forest and shrub/steppe** groups

Footnotes to WNF Landtype Association Table

*1 As mapped LTA **A** includes cirque basins as well as trough headwalls and ridges. These landforms range significantly in site characteristics. The majority of LTA **A** is represented by steep rocky trough headwalls. The hazards indicated reflect properties and processes of this landform and not of cirque basins unless otherwise footnoted.
*2 Surface erosion and sediment delivery commonly increase to high along channel banks.
*3 Soil compaction increases to high in cirque basins
*4 Deep-seated failure hazard increases locally, depending on mineralogy of underlying bedrock.
*5 Debris slide hazard often increases to high following natural or man caused disturbance.
*6 Soil moisture stress is low in cirque basins.
*7 Soil moisture stress increases to moderate on sideslopes not underlain by glacial till deposits.
*8 Surface runoff is generally low in cirque basins.
*9 Subsurface water storage is much higher than rated in cirque basins.
*10 Subsurface water storage may be limited on southfacing slopes where till has been removed due to erosion or mass wasting.
*11 Due to high subsurface water storage, cirque basins are important to the regulation of late season stream flow.
*12 Low (L) = < 6 drainages/sq. mi.; Moderate (M) = 6-10 drainages/sq.mi.; High (H) = 10-20 drainages/sq.mi.

Appendix F-5

V. Describe Past and Current Watershed Condition
VI. Describe Current Trends and Predict Effects of Future Management

PURPOSE
Discuss watershed condition, historical and current, within the context of natural range of variability. Identify significant influencing factors and affected processes. Define desired ecological condition for hillslope, riparian, stream channel and aquatic habitat.

Past, current and desired conditions are incorporated into the discussion for each stratification - transport, transitional and depositional.

Appendix F-5.1

TRANSPORT ZONE

The transport zone includes five FPUs located in the upper Entiat and headwaters of the Mad River (Figure F-3.1). Table F-4.1 lists these FPUs and summarizes key descriptive parameters. The North Fork Entiat and Upper Entiat were selected as representatives of this zone.

Watershed Setting

Landtype associations A and B are dominant in the upper Entiat. These associations include the glacial cirque (A) and glacial trough (B) landforms. Cirques formed in the heads of valleys carved into troughs by glaciers. Troughs are characterized by U-shaped valleys with straight or slightly concave slopes with parallel patterns of shallowly incised low order drainages.

About ⅓ of this zone is now wilderness. Existing vegetation patterns are controlled by continental climatic conditions that prevail in the upper precipitation zone of the subbasin (e.g., N. Fork Entiat 60 inches per year). Soil moisture is not limiting, but cold temperatures do control vegetative patterns. Closed canopy subalpine fir and mountain hemlock are the predominant series associated with alpine meadows and barren rocky peaks.

Historical Conditions

Vegetation: Vegetation in the upper Entiat was probably heavy to mountain hemlock, Douglas-fir, lodgepole pine, subalpine fir, and Engelmann spruce. A variety of herbs and forbs occurred in the meadows of the upper watershed slopes.

The sheep trailing along the upper ridges would have left a network of trailing terraces still evident on some ridges and open grassy hillsides at higher elevations. The existing grassy understory communities became aligned with the terracing and developed parallel strips of vegetation separated by non-vegetated terraces. Bedding and nooning grounds became sites filled by undesireable species. Trapping removed beaver and other fur bearers from the upper watershed, so that they now occur in lesser numbers than historically. The fire regime in this high elevation zone tended to be infrequent fires of moderate to high intensity, which occurred as small isolated pockets or large patches resulting from stand replacement events.

Riparian/Channel/Fish: Stream channels in this portion of the watershed reflect the U-shaped glaciated valley form. Drainage density is relatively low, averaging 1.3 miles of stream per square mile. Lower order streams are incised and originate in hanging valleys and cirque basins. Higher order streams, such as the upper Entiat, in this zone are characterized by unembedded cobble/gravel sediment and have been cut within glacial colluvium.

These streams are mostly within wilderness or unroaded areas and have not been greatly impacted by past management, except in localized areas from historic concentrated sheep grazing. Thus the current condition largely describes the past condition. Springs and seeps are common in the headwater areas. Floodplain marshes and side channels are characteristic of the low gradient (three to five percent) upper Entiat. Riffle habitat dominates (>80 percent), with aquatic diversity within riffles provided by wood and boulder-created plunge pools. Glides, side channels, and large pools make up the remaining instream habitat.

The transport zone contains all of the major lakes of the Entiat subbasin: Ice Lakes, Larch Lakes, Myrtle Lake, Fern Lake, Two Little Lakes, Mad Lake, and Lost Lake. These are all glacial ice-scour lakes.

Management Influences

Old sheep trailing areas will likely still manifest evidence of soil compaction which will limit understory composition. The old sheep trailing created numerous terraces which are still evident on some ridges and open grassy hillsides at higher elevations (Graham Mtn; Big Hill to head of North Fork). These old terraces tend to divert and concentrate runoff. Old sheep bedding grounds support heavier concentrations of undesirable forbs than that which occurred naturally. Bedding and nooning grounds, for instance, now favor undesirable antenaria species.

Timber harvest has been relatively recent (during the last three decades) and only in the lowest portion of this zone (e.g., North Fork Entiat).

Developed and dispersed recreation, an extensive trail system (162.7 miles of trails - the highest of all three zones) and fire exclusion predominate the current management influences. The trails and lakes of this zone have drawn heavy recreational use at some developed and dispersed sites resulting in localized compaction, damaged understory vegetation, erosion and degradation of bank stability.

Existing and Desired Ecological Conditions

Hillslope Processes

Existing Condition: Vegetative cover has been altered due to grazing, harvest activity and fire exclusion (to a lesser extent). The result has been changes to species composition and distribution. This alteration has favored shade tolerant species such as grand fir and western hemlock, as well as the encroachment of trees into meadow areas that were formerly maintained by natural or human caused fire. The Headwaters Mad FPU contains a significant deposit of glacial till which stores a tremendous amount of near-surface groundwater.

Desired Ecological Condition: Vegetative conditions will be promoted and maintained to provide canopy and ground vegetation densities that maximize well-regulated transfer of precipitation and snowmelt into the soil profile.

Specifically, within the area that **naturally supported forest communities** (i.e., closed and open subalpine groups):

a) Maximize infiltration of precipitation and melt in order to minimize surface runoff
   * Promote development and maintenance of absorbent duff layer
   * Decrease compaction
   * Promote vegetative ground cover
b) Maintain canopy to provide effective evapotranspiration and interception to buffer storm events
c) Provide large woody material for long-term soil productivity and potential and instream LWD
d) Maintain naturally ocurring fire frequency and intensity (> 45 years)
e) Maintain the integrity of near-surface groundwater movement
   * Promote percolation of moisture through the profile--decrease compaction
   * Minimize interception, concentration and rapid delivery of **sub-surface flows** routed to the channel area as a result of road/trail cut slopes, etc.
f) Root cohesion and evapotranspiration provided by sustainable vegetation are maintained or restored on steep slopes with high mass wasting hazard.

Aquatic Processes: Riparian Zone

Existing Condition: The amount of road located within 300 feet of a stream channel in the Transport Zone is 6.6 miles and road densities are below 1 mile/square mile. Existing riparian vegetation consists of grand fir, Engelmann spruce, Douglas-fir, lodgepole pine, grasses and forbs. LWD recruitment and shade levels are predominantly good to excellent. Riparian zone function as a buffer to stream sediment input is adequate where vegetative ground cover is good.

Five developed campgrounds are located within riparian areas of this zone. Recreation-related impacts (soil disturbance-compaction, erosion; vegetation disturbance-trampling, firewood cutting) are mostly localized and minimal. The exception is Cottonwood Campground where these impacts are considered detrimental to riparian habitat, bank stability and water quality.

Desired Ecological Condition: Riparian conditions will be promoted and maintained to:

*Maximize storage of sub-surface flows received from upslope; maintain water table levels
*Allow for a fully functioning floodplain; provide adequate riparian vegetation to stabilize channels during normal storm events
*Provide for metered passage of streamflows over the entire year (allow for instream and floodplain LWD recruitment)
*Provide for adequate levels of shade and canopy cover
*Reduce recreation-related soil/vegetation disturbance at Cottonwood CG.
*Negative trends in conditions do not develop at other streamside campgrounds.

Aquatic Processes: Stream Channel Function

Existing Condition: Downed instream wood levels (single large pieces and jams) are fair to excellent in this zone. Approximately 50 percent of surveyed reaches meet the Forest Plan standard of 100 key Pieces per mile. Some reaches are in non-forested areas and naturally do not meet the standard. Removal of large debris jams to protect recreational facilities (bridges, campgrounds, trails) has occurred on the upper Mad and upper Entiat Rivers.

Fewer than 25 percent of the reaches meet the Forest Plan standard for pool habitat. The reasons for not meeting the standards are primarily due to the presence of high gradient reaches (e.g., >10 percent) which are naturally highly variable in pool habitat, and because the survey protocol defines pools differently than the Forest Plan (e.g., channel spanning pool data, only, is available from the stream surveys). Numerous falls may be barriers to resident fish migration in the streams of this zone. Excessive bank erosion was noted in South Pyramid Creek (USDA 1993a) where heavy sheep trailing historically occurred. The remainder of the zone is not heavily impacted by recent management, except for the roaded areas in the lower portions of the Upper Entiat and North Fork Entiat and some well-used recreational sites and trail/stream crossings.

Desired Ecological Condition: Healthy functioning stream channels will be promoted and maintained, such that:

*No excessive aggradation or degradation leading to overall changes in channel type or longitudinal profile is occuring
*Energy dissipating channel features (debris jams, step-pools) are maintained that allow for well metered passage of streamflows and bedload
*Shade and instream cover will be maintained to provide optimal temperatures for bull trout and other aquatic organisms
*Side channels, seeps, and springs will be protected and maintained.

Aquatic Processes: Fish Habitat

Existing Condition: The overall condition of fish habitat for all life phases within this area is fair to excellent.

Rearing/Holding: Fair to excellent in fish bearing segments.
Off-channel winter rearing: Fair to good.
Spawning: Fair to good where suitable habitat exists.
In-channel winter rearing: Fair to good.
Resident adult habitat: Good, except in localized areas.

Riffle habitat dominates, with small percentages of glide and large pool habitat. A comparison of 1935/37 and 1992/94 Entiat River surveys shows large pool habitat has increased by 8 percent to 28 percent. A comparison of 1935/36 and 1990 Mad River surveys shows large pool habitat increased by 210 percent in one survey section and decreased by 88 percent in another reach. Habitat diversity is provided by plunge pools and pocket pools in riffles that are formed primarily by boulders and instream woody material. Seeps and springs are locally numerous. Some reaches have side channel habitat.

No anadromous fish utilize this zone, Entiat Falls is a complete upstream migration barrier. Resident salmonids (rainbow trout, cutthroat trout) dominate in this zone. Resident trout have been noted to occur up to a bedrock canyon in the upper Entiat just upstream from the Ice Creek confluence. Annual stocking (WDF&W) supplements native populations of both species. No information about the historical abundance and distribution of these species is available.

Eastern brook trout were introduced above Entiat Falls earlier this century. This species is no longer stocked. A self-sustaining population persists. Increasing recreational harvest of resident salmonids has resulted from an extensive trail system that also facilitated extensive fish stocking, especially in the following lakes (Wolcott 1964):

Name of Lake	Species	Year First Stocked
Two Little Lakes	cutthroat trout	1946
Ice Lakes	cutthroat trout	1949
Larch Lakes	cutthroat trout	1953
Myrtle Lake	E. brook trout	1935
Fern Lake	rainbow trout	1932
	cutthroat trout	1955
Mad Lake	cutthroat trout	1950

Desired Ecological Condition: Existing native salmonid stocks will be viable and unimpacted by hatchery and introduced fishes. Spawning, rearing, and holding habitats will be protected from management impacts. Deep pools and adequate cover from large woody material and well-vegetated banks will be maintained for all aquatic species. Substrate fine levels will be acceptable for successful resident salmonid spawning and for other aquatic organisms.

Appendix F-5.2

TRANSITIONAL ZONE

The transitional zone includes five FPUs located in the upper-middle portion of the Entiat and Mad River drainages (Figure F-3.1). Table F4.2 lists these FPUs and summarizes key descriptive parameters. Middle Mad River and the Upper Mid-Entiat were selected as representative of this zone.

Watershed Setting

Landtype association C is dominant in the transitional zone, with smaller areas of LTA's A and B. These associations include glaciated mountain slope (C), glacial cirque (A) and glacial trough (B) landforms. Glaciated mountain slope lands comprise the transition between troughs and mountain slopes beyond the limits of glaciation. The relatively mid to high elevation slopes in these landforms have highly variable erosion and sediment delivery rates depending on slope, roughness, soil type and degree of dissection. Slopes less than 40 percent are most common. Low gradient areas have higher subsurface water storage and reduced surface erosion and sediment transport. This zone is characterized by rapid sediment transport in high gradient reaches, high coarse-textured sediment supply and perennial, high-energy streamflow regimes. Indicative of these processes are the dominant channel substrates of gravel, cobble and boulders found in this zone.

The majority of the transitional zone has a relatively moderate mean annual precipitation (e.g., Upper Mid-Entiat 50"/year) and is within the forested zone. Given its location, flood events resulting from high intensity convective storms are a dominant factor in the transport and deposition of sediment in this zone. This zone is also subject to high runoff from rapid melt or rain-on-snow events (e.g., Fox Creek flood/debris torrent in 1972).

Historic Conditions

Vegetation: This zone was characterized by a mosaic of small patches of dense Douglas-fir stands in protected sites interspersed with park-like stands of mature ponderosa pine. The understory vegetation in the park-like areas was primarily pine grass associated with the shrub ceanothus. The understory vegetation associated with the dense patches of Douglas-fir was predominantly shrubs (snowberry, serviceberry, Douglas maple, ocean spray and elderberry) associated with some grasses and forbs. In addition, closed-canopy subalpine fir associated with an occurrence of mid-level shrubs characterized the higher elevations.

Riparian/Channel/Fish: Stream channels in this zone reflect its glacial history. Most tributaries emerge from post-glacial hanging valleys and cross extensive alluvial fans before joining the mainstem Upper mid-Entiat. The Upper and Middle Mad River is moderately entrenched in a deep bedrock valley. Pre-settlement riparian and channel conditions in this zone are unknown. A comparison of stream surveys from the 1930's and 1990's indicates that, in terms of large pools per mile, the Mad River is recovering from turn-of-the-century conditions (1888 fire?). A similar comparison of Entiat River surveys shows a decline in large pools per mile.

Management Influences

Moderate to heavy sheep trailing and grazing from the late 1890's through the 1930's has resulted in degradation of soil productivity and changes in vegetative structure. Old sheep bedding grounds will be supporting heavier concentrations of undesirable forbs than that which occurred naturally. Old sheep trailing areas will likely still manifest evidence of soil compaction which will limit understory composition. Trailing also created terraces which are still evident on some open grassy hillsides. These old terraces will tend to divert and concentrate runoff.

Road-building and logging activity for fire-salvage in the Brennegan-Preston FPU began in the early 1970's. Low standard roads and culverted stream crossings were common. Initial harvest was directed at large-sized commercially valuable species, especially ponderosa pine and Douglas-fir. The 1980's brought new entries to salvage blowdown in the Billy Ridge area (upper Mad FPU) and the Lake-Silver-Pope FPU. The Tyee Road was extended to facilitate harvest of lodgepole pine for local industry. The moderately high road density (Mean = 3.2 mi/sq mi) and relatively low number of road miles in the riparian corridor (Mean = 8.7 miles/FPU) reflect this development history.

Recreational use of this zone is high, evidenced by the five developed campgrounds and 66.8 miles of trails here. Recreation-related impacts (soil compaction, fords, eroding soil, riparian trails) tend to be localized and minimal. Removal of large debris jams to protect recreational facilities (bridges and trails) has occurred infrequently in the upper and middle Mad FPU's. Increasing recreational harvest of resident salmonids (especially bull trout) has been facilitated by an extensive trail system.

Within this zone, are the points of origin of the 1970 and 1994 fires. Not surprisingly, fire suppression and prevention activities have been extensive here - lookouts, guard stations, fuel breaks, firelines, and prescribed burning. Fire suppression has significantly increased tree stocking resulting in multi-storied closed stands.

Existing and Desired Ecological Conditions

Hillslope Processes

Existing Condition: Continental climatic conditions strongly influence vegetative communities. Soil moisture is normally not limiting coniferous stocking. Low to moderate slope gradients and pockets of glacial deposits in meadows and riparian areas contribute to moisture retention. High available soil moisture in surface soils increases the compaction hazard in much of this area, and most particularly in wet meadows. Closed canopy Douglas-fir and grand fir series are the predominant series, except where extensive stands of even-aged lodgepole pine dominate the higher elevations of the Middle Mad and Lake Creek basin.

Vegetative cover has been altered due to historic activities, especially where grazing occured. Grazing directly altered vegetation by removal of more palatable species and by detrimental soil disturbance. Indirectly soil compaction reduced infiltration rate and increased surface runoff and erosion which increased moisture stress on drier sites. In wet meadows and riparian areas, sheep competed with beaver for willow, effectively reducing beaver population. This may have contributed to lowering of the water table in areas and encroachment of coniferous trees into historically wet meadows.

More dense forest communities have developed in the DF series. Reductions have also occurred in both the shrub layer and vegetative ground cover, especially in old sheep trailing areas. The altered ground cover has not been adequate in some locations to protect the soil surface from erosional forces generated during convective storms and snowmelt-related events. Increased surface erosion is a problem particularly along roads and areas detrimentally disturbed by displacement. Large fires have created debris slides on steep slopes draining into the Entiat River. Fine sediment has accumulated in natural catchment basins in the Upper Mad and Lake-Silver-Pope FPUs and is transported mostly during extreme runoff events. Sediment transport dominates in the remainder of this zone.

Due to the long history of fire suppression, unburned sites have high fuel loading and dense stand structure with closed canopies. Some of this area was involved in the 1970 fires which burned large acreages leaving dense stands of sapling lodgepole pine and Douglas-fir. The Tyee Complex fire left 40 percent to 70 percent check this of the mid to upper Mad River watershed in moderate to high intensity burned condition.

The Lake-Silver-Pope and Upper Mad FPUs contain significant deposits of glacial till and alluvial deposits which store a tremendous amount of near-surface groundwater. Seeps and small springs are associated with stream channels. Roads in these catchment basins have dissected these till deposits, diverting near-surface flows to the surface. Interception and concentration of flows has caused erosion of road surfaces and sedimentation in low gradient stream reaches.

Desired Ecological Condition: Promote and maintain vegetative conditions that provide canopy and ground vegetation densities and that maximize the probability of a well-regulated transfer of precipitation and melt into the soil profile.

a) Maximize infiltration of precipitation and melt in order to minimize surface runoff
   * Promote development and maintenance of absorbent duff layer
   * Decrease compaction
   * Promote vegetative ground cover

b) Maintain canopy to provide effective evapotranspiration and interception to buffer storm events

c) Provide large woody material for long-term soil productivity and potential and instream LWD

d) Maintain naturally-ocurring fire frequency and intensity (>45 years)

e) Maintain the integrity of near-surface groundwater movement
   * Promote percolation of moisture through the profile--decrease compaction
   * Minimize interception, concentration and rapid delivery of **sub-surface flows** along the way to channel areas as a result of road/trail cut slopes, etc. For sub-surface flow interception concerns, place special emphasis on landform units B and C which are typical of upper Mad and upper Entiat because of near-surface storage characteristics and influence on baseflows.

f) Viable willow stands and beaver populations exist in wet meadows.

g) Mass wating occurs within natural thresholds by maintaining root cohesion and evapotranspiration on sites prone to high mass wasting hazard.

Aquatic Processes: Riparian Zone

Existing Condition: There are 43 miles of road located within 300 feet of stream channels in the Transitional Zone (range 6.5/FPU to 13.0/FPU). Most roads are native surface with minimal surface water control features. Existing riparian vegetation consists of red cedar, grand fir, and occasional dogwood and alder lower in this zone, with the addition of Engelmann spruce and western hemlock in the riparian of the higher elevation reaches. LWD recruitment and shade levels are predominantly fair to excellent. Riparian zone function as a buffer to stream sediment input is adequate where vegetative ground cover is good.

Desired Ecological Condition: Promote and maintain riparian conditions that:

Maximize storage of sub-surface flows received from upslope; maintain water table levels
Allow for a fully functioning floodplain; provide adequate riparian vegetation to stabilize channels during normal storm events
Provide for metered passage of streamflows over the entire year (allow for instream and floodplain LWD recruitment)
Provide for adequate levels of shade and canopy cover
Provide habitat for riparian dependent wildlife (amphibians, grouse, beaver)

Aquatic Processes: Stream Channel Function

Existing Condition: Downed instream wood levels (single large pieces and jams) are fair to excellent in this zone where >50 percent of stream reaches meet WNF LRMP Standards. Blowdown has recruited LWD input in several areas surveyed, e.g., portions of Cougar Creek (USDA 1991b), Lake Creek (USDA 1991c). The Upper Mad FPU contains about one-half of the Mad River bull trout habitat. Fine sediments have been noted from heavily- logged small tributaries and road crossings. Because this area is less management-impacted than the lower Entiat Basin, the excessive fine sediment areas appear to be localized to impacted stream reaches.

Desired Ecological Condition: Promote and maintain healthy functioning stream channels:

No excessive aggradation or degradation leading to overall changes in channel type or longitudinal profile
Maintain energy dissipating channel features (debris jams, step-pools) that allow for well-metered passage of streamflows and bedload
Maintain shade and instream cover that provides optimal temperatures for bull trout and other aquatic organisms

Aquatic Processes: Fish Habitat

Existing Condition: The overall condition of fish habitat for all life phases within this area is fair to excellent.

Rearing/Holding: Fair to excellent in fish bearing segments.
Off-channel winter rearing: Fair to good.
Spawning: Fair to excellent where suitable habitat exists.
In-channel winter rearing: Fair to good.
Resident adult habitat: Good, except in localized areas.

Fish habitat, in terms of pools and LWD, ranks highest in the transitional zone. Impacts of roads and tributary harvest have led to localized accelerated sedimentation and habitat simplification. Unimpacted reaches provide excellent cover from woody material and streamside vegetation. Riffle habitat dominates, with small percentages of glide and large pool habitat. A comparison of 1935/37 and 1990/94 Entiat River surveys shows large pool habitat has decreased by 31 percent to 60 percent in this zone. A comparison of 1935/36 and 1990 Mad River surveys shows large pool habitat has increased by as much as 1,000 percent between river miles 4 and 10, a probable indication of recovery from the 1888 Mad River fire. Habitat diversity is provided by plunge pools and pocket pools in riffles that are formed primarily by the instream woody material.

This zone contains the upper limit of anadromy in both the Entiat and Mad Rivers. Anadromous fishes utilizing this zone include: spring chinook, late-run chinook, and summer steelhead. These species have experienced a spiky decline since the turn of the century (ECRBS 1979, WDF et al. 1990).

This zone is a bull trout stronghold although decreased from historical abundance (Brown 1992). Mad River bull trout spawning trend has been stable from 1989 to 1995 (USDA 1995a). Significant populations of rainbow and cutthroat trout are found in this zone.

Desired Ecological Condition: Existing native salmonid stocks should be viable and unimpacted by hatchery and introduced fishes. Spawning, rearing, and holding habitats should be protected from management impacts. Deep pools and adequate cover from large woody material and well vegetated banks would be present for all aquatic species. Substrate fines would be within an acceptable level for bull trout spawning and for other aquatic organisms.

Appendix F-5.3

DEPOSITIONAL ZONE

The depositional zone includes ten FPUs located in the lower portion of the Entiat and Mad River watersheds and along the Columbia River Breaks (Figure F-3.1). Table F-4.3 lists these FPUs and summarizes analysis elements. Mud Creek was selected as an FPU representative of this zone.

Watershed Setting

Landtype association "E" is dominant in the depositional zone. This association is comprised of both mountain slopes and strongly dissected mountain slopes located beyond the limits of glaciation on the eastern part of the Entiat Analysis Area. Upper slopes and ridges are generally convex with V-shaped valleys and closely spaced lower order drainages (150-500 meters apart). These steep, low to mid elevation mountain slopes have both high erosion and sediment delivery rates.

Native materials are moderately coarse textured granitics, gneiss, and schists, mantled by fine textured ash and loess with weathered rhyolite in some areas. This association is also characterized by deposition (storage) of sediments due to the high sediment supply, intermittent flow regimes, drainage density and occurrence of lower channel gradients, especially in the lower reaches. This aggradation process is indicated by the accumulation of alluvial fan deposits at the mouths of all the tributaries. Acreage of alluvial fans in FPUs in this zone varies from 200 to over 900 acres.

The majority of this zone has a relatively low mean annual precipitation (e.g., Mud Creek 25 inches per year) and is located along the transitional zone between grass and forestlands and has the most complex distribution of vegetation in the watershed. Flood events resulting from high intensity convective storms are a dominant factor in the transport of sediment in this zone. Surface erosion and debris flows are commonly triggered by storms following wildfire. Rapid melt or rain-on-snow events may also result in high runoff from this zone, primarily from the higher elevations.

Soils formed mainly in volcanic ash and loess mixed with or overlying coarser textured residuum weathered from gneiss, schists and granites. LTA E has high soil moisture stress due to well drained subsoils, rapid runoff and low annual precipitation. Available water capacity is highest in ash and loess soils at the surface. Loss of this fine textured soil by erosion reduces the soil water available for shallow rooted vegetation. Soil compaction reduces the infiltration rate and depth, and increases surface runoff and erosion which effectively increases soil moisture stress. This results in deeper rooted grasses being replaced with shallow rooted species which hold moisture closer to the surface where it is more easily lost to evaporation.

Historic Conditions

Vegetation: Historic vegetation in this zone was variable with vegetation type strongly influenced by site specific factors including: aspect, slope shape and gradient, soil texture, and occurrence of seeps and springs. A large portion of this zone was probably heavy to perennial grasses and forbs with few annuals. These perennial species were associated with an occurrence of mid-level shrubs and an occasional mature ponderosa pine or Douglas-fir tree.

Drier conditions predominate in the Columbia River Breaks, foothills and south slopes of low elevation mountains. Historic vegetation in these areas was mainly heavy to perennial grasses and forbs with few annuals. These perennial species were associated with mid-level shrubs and scattered individuals or small stands of mature ponderosa pine or Douglas-fir. Significant pockets of closed canopy Douglas-fir and ponderosa pine forest occurred on moister concave slopes, north aspects and at upper elevations. Much of the area is in a transitional zone where open park like ponderosa pine with a grassy understory is most characteristic.

Riparian/Channel/Fish: Stream channels in this zone reflect fluvial downcutting. The valleys are predominantly V-shaped with high drainage densities averaging 1.74 miles of stream per square mile. Riparian vegetation was dominated by grasses, perennial forbs, shrubs, and deciduous trees such as cottonwood, willow and aspen. Channel density, steep slopes, rapid runoff and highly erodible soils combine to efficiently deliver sediments to the narrow valley bottoms. Pulses of shallow rapid failures following fires are common in this zone. A repeating cycle of valley bottom aggradation and downcutting reflects the short term disturbance response and longer term recovery and climatic trends.

Beaver were a dominant factor in many locations providing for maintenance of riparian areas and sustainability of low flows. Streams with resident beaver were less incised, exhibiting more of a "step-down" longitudinal profile which promoted water storage and habitat diversity. Erosion and sedimentation occurred within a natural range, with "pulses" of sediment due to natural causes. Fire-related events were a dominant disturbance mechanism in the lower watershed.

Historic fish population conditions were described (ECRBS 1979) as:

> "Significant runs of chinook salmon, coho salmon, and steelhead trout occurred in the Entiat River prior to 1898. The last sizable chinook run occurred in 1904 and very few fish remained by 1925. Stream surveys conducted in the 1930's found the River almost devoid of salmon."

Management Influences

Excessive grazing by sheep, cattle and horses from the late 1890's through the 1930's has resulted in degradation of soil productivity and changes in vegetative structure. Concentration of stock in riparian areas resulted in soil compaction and reduced vigor or loss of desirable perennial grass species as well as low to mid level shrubs. Less desireable annuals and noxious weeds invaded these sites and those tall shrubs that survived were hedged and decadent.

Extensive grazing on south facing slopes resulted in loss of top soil which favored establishment of tree seedlings instead of native, perennial grasses. The survival of these "encroaching" trees was enhanced by the concurrent decrease in grazing and increase in fire suppression occuring in the 1930's. The relatively dense pole stands that resulted occupied areas that historically supported only a few trees. Loss of the grassy understories common to this area allowed for accelerated erosion on sites with very thin topsoils. It is suspected that soil conditions have changed (loss of top soil) and it may be difficult to re-establish a grassy understory especially on south slopes. Without a vigorous grassy understory, it may be difficult to use under-burning as a tool to maintain park-like stands of ponderosa pine and Douglas-fir. Refer to Appendix IV for more details on grazing history.

Logging activity for construction and the apple box industry began increasing early in the century. Initial harvest was directed at private lands, especially holdings of the Northern Pacific Railroad Company. Early activities focused on roading and timber harvest up the valley bottoms. Mud Creek was one of the first major tributaries to be developed. Access and the presence of high value species has led to roading and multiple entries over much of this zone. The high road density (Mean = 3.5 mi/sq mi; Range 1.4-7.3 mi/sq mi) and high number of road miles in the riparian corridor (Mean = 21 miles per FPU; Range 6.0-36.2 miles) reflect this development history.

Streams in this zone have been significantly altered by human activity. In the non-Federal lands along the lower mainstem, the River has been modified by development and by rehabilitation work conducted following major events such as the 1948 Flood. Road construction and timber harvest within and adjacent to riparian areas has reduced the supply of large woody debris and the occurrence of related channel features (e.g., pools).

Historically the major intermittent tributaries are suspected to have had more stable flow regimes. The flow regimes have changed due to a number of factors including elimination of beaver, riparian modification and changes in upslope vegetation and hydrologic regime, in part due to the effects of grazing and fire suppression. The riparian vegetation in the non-forested areas has changed over time from one dominated by shrubs, perennial forbs and grasses to less palatable annual and perennial grasses with a reduction in shrubs. Streambank conditions were degraded by intensive grazing within riparian areas in many drainages.

The products of both natural and accelerated erosion are aggrading in many stream channels in this zone in the absence of major transport events. Roads represent a significant source of the accelerated erosion on Federal lands. Roads also confine stream channels in narrow valley bottoms which leads to increased channel entrenchment and lowering of the water table. These changes, along with existing drought conditions, have all contributed to the shift from perennial to intermittent and sub-surface flows in drainages such as Mud Creek.

Recreational use in this zone is ~~lowest of all three zones; one developed campground and~~ 20.93 miles of trail (0.08 miles per square mile - mostly in the lower-mid Entiat FPU).

Existing and Desired Ecological Conditions

Hillslope Processes

Existing Condition: Vegetative conditions in this zone reflect a decrease in perennials with an increase in annual species, noxious weeds, a loss of mid-level shrubs and mature ponderosa pine and Douglas-fir, and an increase in pole and sapling size trees of the same species. Historic activities, especially grazing, have resulted in a loss of ground cover and surface soils and an increase in compaction. These factors have resulted in a decrease in infiltration and an increase in surface runoff and soil moisture stress. The type and condition of existing understory vegetation is not conducive to rapid recovery of infiltration rates. This zone includes the transition zone between grasslands and forest. Moisture is limiting to growth and stocking for at least a portion of the growing season.

The Dinkleman (1988) and the Tyee Complex (1994) Fires have affected a large portion of this zone. Both fires involved large, continuous acreage of moderate to high intensity burn resulting in cover loss and development of hydrophobic soils in some areas. Soil vegetative cover is still recovering on much of the Dinkleman Fire area. The area and magnitude of the Tyee Fire was extensive, with drainages such as Mud Creek having 78 percent of the area burned at a moderate or high intensity (11,355 acres). Soil vegetative cover has been removed over much of the burned area.

The potential for increased surface runoff, erosion and flooding is high in many affected tributaries. Since the 1994 Tyee Fire, many formerly intermittent tributaries within the burned area (Tyee Creek, Shamel Creek, Dill Creek, Potato Creek, Mud Creek) have sustained perennial flow. Past events support the concept that the large blackened slopes resulting from wildfire promote the destabilization of air masses and development of thunderstorms. Mud, Potato, Stormy and other lower Entiat watersheds were high priorities for emergency burned area rehabilitation efforts in response to the Tyee Complex. A key component of this work was seeding and fertilization to replace soil cover in order to reduce surface runoff and erosion.

A majority of the moderate to high burn intensity consists of standing dead coniferous trees. Left to natural events these standing dead trees will fall creating a heavy fuel buildup. It is expected that natural seeding will produce extremely heavy regeneration that will be incorporated with this heavy fuel load. This situation could perpetuate conditions favorable to high intensity fires.

The depositional zone encompasses 171,843 acres. Approximately 90 percent of this area has been involved in catastrophic, large scale fires. Frequent, low intensity fires area natural disturbance for the vegetative communities in this zone; however, as much as 46 percent of this area has been subjected to moderate to high intensity burns. The area has a history of serious flooding and an increase in debris flow hazard in the following one to two years after fires. A high hazard of deep seated failure is locally present (Blackburn). Floods and debris flows originating in the upper watersheds result in deposition on alluvial fans in the lowlands, with a high risk for public safety and property damage.

Roads have also concentrated runoff and accelerated delivery of both water and sediment to downslope locations. A high road density exacerbates soil moisture stress by intercepting and effoiciently channeling the limited subsurface and surface water to streams. This decreases moisture available to the soils and vegetation and increases peak flows. Sediment from a variety of sources is being delivered to drainageways (ephemeral draws and 1st and 2nd order channels) but most of this material is being stored and not transported through the system. This sediment is accumulating in lower valley positions and is subject to transport from major runoff events (e.g., high intensity convective storms).

Desired Ecological Condition: Promote and maintain vegetative conditions (composition & densities) that provide for the well-regulated transfer of precipitation and melt into the soil profile, within the natural capability of the site. In general, provide for or maintain the naturally occurring vegetative mosaic. Where grassland communities or park-like forest stands (Dry series - high and low density PP and DF) were supported naturally:

a) Promote plant communities that produce organic matter high in bases and base cations--i.e., promote grassland understory plant communities; vegetative mosaic reflects site characteristics across the landscape
b) Avoid organic matter accumulation that is more acidic that could produce hydrophobic (non-wettable) conditions (i.e., needle duff)
c) In order to maintain healthy grassland plant communities, promote frequent, low-intensity fires. Soils in these areas evolved with grassland understory communities with open park-like forest canopies.
d) Avoid understories that consist of coniferous saplings and seedlings
e) Maximize infiltration of precipitation and melt (decreased compaction, adequate ground cover, etc.)----> minimizing overland flow
f) Promote movement of water through the soil profile into near surface groundwater--> promote percolation, decrease compaction, etc.
g) Minimize interception, concentration and rapid delivery of surface and sub-surface flows by roads

Aquatic Processes: Riparian Zone

Existing Condition: Miles of road located within 300 feet of a channel in the Depositional Zone averages 21 miles per FPU (205 miles total). Most roads are native surface with minimal surface water control features. Stream-adjacent roads and associated management have reduced large woody debris (LWD) recruitment.

In some reaches loss of vigorous shrubs in the riparian zone has reduced instream organic input, reduced shade, and contributed to unstable stream banks and associated erosion. Existing riparian vegetation consists primarily of conifers (ponderosa pine and Douglas-fir) with alder, willow, cottonwood, aspen, elderberry, and maple being the dominant deciduous species. LWD recruitment and shade are variable, ranging from poor to good (only 25 percent of surveyed reaches meet 100 pieces/mile standard). Riparian zone function as a sediment delivery buffer is poor in the roaded segments and in some of the riparian zone that is not roaded.

Desired Ecological Condition: Promote and maintain riparian conditions that:

a) Maximize storage of sub-surface flows received from upslope; maintain or raise water table
b) Restore naturally functioning floodplain; provide adequate riparian vegetation to stabilize channels during normal storm events
c) Provide for well-regulated movement of streamflow over the entire water year through the channel system (promote step-pools, beavers)
d) Provide for adequate levels of large woody debris and shade

Aquatic Processes: Stream Channel Function

Existing Condition: Some stream segments are artificially constrained and simplified by roads, agriculture, other developments and channelization. The confluences of the minor Columbia River Tributaries (Swakane, Spencer, Byrd, McKinstry) have been permanently and drastically altered by road fill for Highway 97A, railroad grade fill, and the creation of Lake Entiat behind Rocky Reach dam on the Columbia River. Increased sediment delivered from hillslopes to channels within this zone has resulted in fine sediment deposition which has also reduced the quality of available habitat. Fine sediments, while a natural component of the ecosystem, are impacting channels through aggradation in many reaches. Sediment delivery has become chronic instead of pulsed, resulting in channels with aggradation that may be outside the natural range of variation. Mud Creek is an example of a high sediment storage area, as are other drainages in the Lower-Mid Entiat. Streambank conditions in some tributaries are poor (e.g., 50 percent or more of surveyed banks in Mud Creek were eroding in 1993).

Desired Ecological Condition: Promote and maintain healthy functioning stream channels:

a) Miles of road impacting stream channels is reduced and a vigorous vegetative cover adjacent to the stream is maintained.
b) No excessive channel aggradation or degradation leading to overall changes in channel type or longitudinal profile
c) Provide for energy dissipating channel features (step-pools, roughness) that allow for well metered passage of streamflows, especially during bankful flows
d) Provide for channel maintenance flows that create fish habitat during low flow periods
e) Do not laterally constrain channels

Aquatic Processes: Fish Habitat

Existing Condition: This zone contains some of the most important habitat for anadromous fish in the Entiat subbasin; however, this habitat is not on Federal lands.

Rearing/Holding: Fair to poor in fish bearing segments.
Off-channel winter rearing: Fair to poor.
Spawning: Fair to poor where suitable habitat exists.
In-channel winter rearing: Fair to poor.
Resident adult habitat: Seasonally poor, overall rates as fair.

The overall condition of fish habitat for all life phases within the depositional zone is fair to poor due to accelerated sedimentation, low baseflows, habitat simplification (loss of pools, reduced side channel habitat, and lack of large woody material), increased water temperatures and human influence (e.g., channelization, clearing, development, roading, irrigation diversion). Anchor ice is also a significant disturbance mechanism in this reach of the Entiat. Past ice flow events have altered habitat and resulted in property damage.

Far fewer than 25 percent of surveyed reaches meet the current Forest Plan standard for pool habitat. A comparison of 1935/37 and 1990/94 Entiat River surveys shows large pool habitat has decreased by 92 percent in the upper reach of this zone. This zone has relatively more shallow pools (depths $\leq$ 1.5 feet) than the other zones which have relatively more deeper pools (see Appendix V). These changes have resulted in reduced quality and an overall reduction of available aquatic habitat. A comparison of 1935/36 and 1990 Mad River surveys shows large pool habitat has increased by 338 percent in the lowest reach of Mad River. This increase is probably a result of the cessation of the early-century practices of splash damming and log driving in this reach of the Mad River combined with the Mad's gradual recovery from the catastrophic 1888 fire in the upper reaches.

The Lower Mid-Entiat is the principal spawning and rearing area for anadromous fishes (spring chinook, late-run chinook, sockeye, and summer steelhead). All these species, with the exception of sockeye, have declined in abundance (ECRBS 1979, WDF et al. 1990). Sockeye established a small (<500 fish) naturally-spawning population through straying from a failed hatchery attempt to produce this species. Coho are listed as extirpated in the Entiat (WDF et al. 1990).

The lower Mad River supports a few spring chinook and summer steelhead. The Mad River was once considered the principal steelhead-producing tributary to the Entiat River (ECRBS 1979). Roaring Creek (USDA 1993c) and Stormy Creek (USDA 1990d) hold healthy resident populations of rainbow trout. Both these creeks are possible historical producers of steelhead. Mud Creek and Swakane Canyon beaver ponds (now fishless) once supported a popular recreational fishery for brook trout (ECRBS 1979).

Following the 1988 Dinkleman Fire, severe flooding caused excessive siltation of the lower Entiat River. According to the WDFW (Bill Zook), this reach of the Entiat experienced a 100 percent fish kill (adults and juveniles) as a result. The Tyee Fire has accelerated the risk of siltation and subsequent fish kills in the lower Entiat. This effect to fish is considered undesirable, yet temporary, as excessive sediment and bedload movement will decrease over time. The accumulation of a sediment delta at the mouth of the Entiat River is responsible for creating an estuary-like environment which could be favorable for fish rearing.

Desired Ecological Condition: Do not reduce genetic variability and viability of the remaining native or natural salmonid stocks (spring chinook, late-run chinook, summer steelhead, bull trout, cutthroat trout, and rainbow trout).

a) Protect spawning, rearing, and holding habitats. Provide deep pools, adequate cover from large woody debris and well vegetated banks for all aquatic species.
b) Maintain the connectivity of habitat throughout the lower drainage. Promote actions by other landowners to provide passage over artificial barriers and properly screen diversions.
c) Discourage the spread of introduced Eastern brook trout.

Appendix F-6

VII. Integrate, Interpret and Present Findings

RESOURCE LINKAGES

Linkages are defined as cause-effect relationships significant in understanding ecosystem function and process. Numerous linkages were identified as a result of stratification and analysis of the Entiat SWF zones and FPU's, and definition of their pre-settlement and current condition.

Refer to the SWF section in Chapter 2 of this document for the list of linkages.

Preliminary Management Strategies

Management strategies respond to differences between the existing and desired conditions. Existing and desired conditions in the three zones were described in the previous section.

Following are some of the proposed management strategies relating to watershed and fisheries resources that resulted from preliminary analysis by the SWF Team during Version 1.0. During synthesis, these preliminary strategies were integrated with those from other resources to produce the Management Strategy tables in Chapter 3 of the Watershed Assessment. Also during synthesis, additional SWF-related management strategies were developed and the strategies were segregated by vegetative group. Please refer to the tables in the Watershed Assessment for a complete listing.

1) Implement management actions that reduce surface runoff and surface and mass erosion from disturbed sites, especially from roads and moderate-high intensity burned areas (e.g., site reveg, log terracing, road obliteration, road surfacing, activity avoidance, etc.).

a) Avoid actions or events (e.g., large fires and roads) which could trigger landslides and accelerate sedimentation.

b) Avoid long, linear overstory alterations up and down hillslopes which can concentrate and rapidly deliver surface runoff to stream channels.

c) Limit ground based, mechanical treatments. Soil disturbance needs to be at a minimum to reduce soil compaction and surface erosion.

d) Minimize surface runoff and erosion from roads within the entire watershed. Obliterate roads reopened as a result of the fire that are not needed for management.

e) Any new ground-disturbing activities (e.g., road construction) must incorporate appropriate surface water control. Ensure that new road construction complies with "no net increase" provisions of the President's Forest Plan (ROD 1994).

f) Encourage the recovery of high and moderate intensity burn areas to reduce surface runoff, erosion and the risk of flooding.

2) Maintain closed canopies in moist forest communities so that:

a) near surface groundwater would not be concentrated and trigger slides

b) the potential for surface runoff during convective storms and rapid melt events would be reduced.

3) On dry series sites, avoid the development of hydrophobic soils (and resulting overland flows and sedimentation) by avoiding high fire intensity and associated high surface temperatures that would effect vegetative recovery. Avoid future occurrence of high intensity burns by removing excess dead trees.

4) On dry series sites where there is a forested understory, manage understory seedlings and saplings in order to minimize the potential for development of hydrophobic conditions. Perpetuate more open park-like conditions. Control the results of natural seed cast from the fire so dog hair stands do not occur.

5) Avoid tree plantings that would perpetuate the need for excessive thinnings to reach sustainable stand structure.

6) Implement management actions that promote maintenance or improvement of riparian area function and channel stability (e.g., riparian road relocation, beaver re-introduction, revegetation, obstruction removal, LWD/boulder placement, etc.).

7) Design and implement analysis process necessary to evaluate the appropriateness of Forest Plan riparian standards to riparian/stream channel systems in the Entiat subbbasin. Initiate sediment source assessment on a subwatershed basis.

8) Implement a coordinated monitoring plan targeted at priority issues.
Emphasize evaluation of recovery of the Tyee Fire.

9) Establish and maintain an early warning system for flood events in cooperation with the National Weather Service, County and other local agencies.
10) Foster coordination with other agencies, private landowners, Chelan County, Chelan County Conservation District and the City of Entiat in order to develop and accomplish mutual watershed management goals.

11) Implement Northwest Forest Plan Riparian Reserves Standards and Guidelines (1994) for all federally-managed lands within the Entiat Analysis Area. Site-specific application of Riparian Reserve S&G's will be accomplished through the NEPA process.

Final Management Strategies
Refer to the SWF sections in Tables 3.2-3.7 in this document.

Appendix F-7

VIII. Manage Information, Monitor & Revise

PURPOSE

This section provides guidance on monitoring and identifies additional inventory and analysis needed to carry forward into future iterations. Additionally, it reflects the importance of the quality of the data available to perform this analysis.

Refer to the monitoring and follow-up sections in Chapter 4 of this document for information related to SWF resources.

Appendix F-8

Geographic Priorities

Watershed analysis is important to ensuring that aquatic system protection is fitted to specific landscapes and is one of the principal steps in making decisions on implementation of the **Aquatic Conservation Strategy** in the Northwest Forest Plan. The approach of the Aquatic Conservation Strategy seeks to prevent further degradation and restore habitat over broad landscapes, as opposed to individual projects or small watersheds.

The Entiat and Mad Rivers have been identified as part of a system of **key watersheds** within the range of the northern spotted owl, that serve as **critical refugia** for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. The **Entiat and Mad Rivers are Tier 1 Key Watersheds** which are designated to contribute directly to the conservation of at-risk fish species (See Appendix F-9-VI).

The overall goal is for the Entiat analysis area, including hillslopes, riparian zones and stream channels, to be in a state of dynamic equilibrium such that these watershed components function properly, are stable and are resilient to a range of natural events. In this context and that of the NW Forest Plan, the maintenance/ restoration of **aquatic habitat** is one and the same with maintenance/restoration of **properly functioning watersheds.**

Overview

Recent analysis work by the Eastside Ecosystem Assessment Team has mapped the distribution of aquatic species of concern in the Columbia River Basin. Distribution is mapped by species according to four major criteria:

(1) **Population stronghold**, (2) **Known present**, (3) **Known absent** or (4) **Unknown.**

This has led to the identification of "focal areas" where salmonid population strongholds remain. These strongholds serve as refugia to maintain genetic diversity and provide sources for rebuilding depressed populations. The "unknown" category is cause for concern because, without presence/absence information, we would not be able to evaluate potential management-related risks and tradeoffs.

Species distribution maps should be used in combination with other data or map layers (e.g., road density, riparian road density, Landtype Association responses) to prioritize FPUs for watershed restoration and to determine management intensity in selected FPUs (See Table 8.1). The following two examples illustrate this process. These data and examples are provided as a guide for more detailed planning and analyses.

Example 1: Conditions within an FPU

Within the Entiat/Mad subbasin, the lower Mad FPU is a bull trout stronghold. Steelhead and spring chinook are present in the lower Mad and late-run chinook and sockeye are unknown. Bull trout are depressed throughout the Columbia River Basin, their strongholds are increasingly isolated in upper tributary drainages, and they are very sediment sensitive (moreso than other salmonids). The lower Mad FPU has the second highest percent fine sediment in salmonid spawning gravel (19 percent fines <1.0mm in 1995) of all sediment-monitored FPUs in the subbasin.

The lower Mad FPU ranks highest of all subbasin FPUs in road density (7.3 mi/sq mi), highest in riparian road density (1.2 mi/sq mi) and is dominantly Landtype Association E (high surface erosion, high sediment delivery, high surface runoff potential). The potential detrimental effects of roads (mainly altered hillslope

hydrology and accelerated fine sediment delivery) are particularly acute in Landtype Association E (See Table F-4.4).

When we interpret the above information in the context of **"watershed restoration to benefit fish habitat"**, the lower Mad FPU emerges as the highest priority within the Entiat/Mad subbasin (see Table F-8.1 to compare other subbasin FPUs). It is clear that road-related sediment reduction would be a beneficial watershed restoration acitivity in the lower Mad FPU.

When we interpret the above information in the context of **"type and intensity of future management actions"**, such as may come from the Dry-Site strategy, the lower Mad FPU may not be appropriate for "testing" techniques or new tools. Risks of taking action (such as riparian silviculture, new road construction, road density reduction) or no action would need to be evaluated for potential effect on the species of concern.

Example 2: Conditions Within & Downstream from an FPU

The Brennegan-Preston FPU is not a stronghold for any fish species. Rainbow trout are found only in the lowest 500 feet of Preston and Brennegan Creeks (up to the hanging valley barrier falls). Other fish species of concern are known absent. More importantly, the streams of this FPU deliver directly to the most significant salmon-spawning reach of the Entiat River, the lower mid-Entiat FPU, which is a focal area for sockeye, spring and late-run chinook spawning. The lower mid-Entiat has the highest percent fine sediment (21 percent fines <1.0mm in 1995) of all sediment-monitored FPUs in the subbasin.

Road density in the Brennegan-Preston FPU ranks second highest (6.6 mi/sq mi) of all subbasin FPU's and riparian road density ranks second highest (1.1 mi/sq mi). The Brennegan-Preston FPU is dominantly Landtype Association C (moderate surface erosion, moderate sediment delivery, moderate surface runoff potential; see Table F-4.4). The moderate debris-slide hazard of this FPU often increases to high following natural or management-caused disturbance such as wildfire or road construction.

When we interpret conditions **within the FPU** in the context of **"watershed restoration to benefit fish habitat"** we might conclude that: (a) fish habitat restoration is a low priority, (b) road-density reduction is needed and would likely benefit aquatic habitat, and (c) there is a low risk to fish and a moderate to high risk to aquatic habitat as a result of the short-term detrimental effects of ground-disturbing restoration activities such as complete road obliteration.

If we reinterpret restoration opportunities under the same conditions, but mindful of the capability of this FPU to deliver fine sediment to its **neighboring FPU** (the lower mid-Entiat), then our conclusions about short-term risk to fish and fish habitat would change from low or moderate to high. Accordingly, we might want to modify a "complete road obliteration" prescription to "remove culverts and road fill in drainageways only" in sensitive locations.

The long-term benefits of other **"types and intensities of future management actions"** (prescribed fire, thinning) in Brennegan-Preston would need to be weighed against the short-term high risk to fish and fish habitat in the downstream FPU. For example, Dry-Site analysis might conclude that timber stands in Brennegan-Preston would benefit from precommercial thinning. The resulting slash load would increase the risk of wildfire and subsequent detrimental impacts on hydrology and aquatic habitat. A plausible prescription would be to use hand-labor instead of heavy equipment and to dispose of the slash by chipping rather than the customary burning or leave-it-as-it-lays.

Geographic Priorities - Aquatic Perspective
Table F-8.1

FPU	Stronghold	Present	Rd Den	Rip Rd Den	%Fines	LTA
Lower Entiat		SH,RB,SC,LC,SE,BT,CT	3.3	0.7	18%	E
Lower-Mid Entiat	SC,LC,SE	SH,RB,BT,CT	3.1	0.6	21%	C/E
Upper-Mid Entiat	BT	SH,RB,SC,LC,CT	1.8	0.3	15%	A/B
Upper Entiat		RB,CT	0.6	0.1	13%	A/B
Lower Mad	BT	SH,RB,SC,CT	7.3	1.2	19%	E
Middle Mad	BT	SH,RB,SC,CT	3.8	0.5		C/E
Upper Mad	BT	RB,CT	1.8	0.2		C2
Headwaters Mad	CT	RB	0.1	0.03		C2
North Fork Entiat	CT	RB	0.8	0.04		A/B
Three-Tommy		RB, CT	0.4	0.08		C2/B
Roaring-Tamarack		RB	4.5	0.3		E
Lake-Silver-Pope		RB	2.1	0.3		C2
Brennegan-Preston		RB	6.6	1.1		C
Stormy-Potato		RB	2.7	0.7		E/C

Appendix F-9

APPENDIX I

Discussion of Percent of Fine Sediments in Stream Substrate Used in Stratification of FPU'S

Erosion and sedimentation have been recognized as problems in the Entat subbasin since as least 1970 (ECRBS 1979). A portion of the problems of erosion and sedimentation

> "...are attributable to natural geologic processes and the effects of a comparatively young river carving a place for itself. These processes were occurring before man's intrusion into the valleys of the Entiat. Erosion and sedimentation from natural processes were soon supplemented by that caused from use of the land", including the grazing of livestock, fire, timber harvest, and road building beginning in the late 1800's."

The Analysis Process

To address the key questions, all available references were reviewed for quantitative and qualitative information about erosion and sedimentation in the Entiat subbasin and its tributaries. These sources included: the 1979 Entiat Cooperative River Basin Study, Production and Habitat of Salmonids in Mid-Columbia River Tributary Streams (Mullan et al. 1992), WNF Sediment Monitoring Reports (1993d, 1994c & 1995b), and WNF Stream Survey Reports (1973-1995). The results of this review were compiled in Table F-9-I-1.

Each subbasin Fish Production Unit (FPU) was assigned a sediment depostion sensitivity rating based on the following criteria:

Red = ≥20 percent fines (<1.0 mm in pool tailouts and glides (WNF LRMP 1990).
Yellow = 15 to 20 percent fines
Green = <15 percent fines.

In four reaches of the Entiat River, the percent fines less than 1.0mm in diameter was known from WNF monitoring sampling conducted in 1993, 1994 and 1995. The percent of fine sediment in the lower Mad River was known from WNF sampling conducted there for the first time in 1995. In other subbasin FPU's, visually estimated cobble embeddedness >35 percent by volume was used as an index of sedimentation. All subbasin FPU's were classified as "transport" or "depositional" based on physical features (gradient, valley width, sinuosity, etc.) and natural processes (geologic history, flow regime, climate, etc.).

Findings

* The natural range of variability of fine sediment loading in the Entiat River subbasin is unknown.

* Three years (1993-1995) of sediment core sampling data indicate that the natural range of variability of fine sediment loading in the Entiat subbasin may be very broad (between 10 and 40 percent fines <1.0mm).

* Comparison of 1993-1995 sediment data with post-1970 fire sediment conditions indicates that the mid to lower Entiat River had experienced a natural recovery from the effects of the 1970 fire. The effects of the 1994 Tyee Fire remain to be seen.

* Mullan et al. (1992) reported that sediment now delivered to the Entiat River from human activity is about 10 percent above natural background levels and that this average will vary with the extent of disturbances in a given watershed. They defined sediment as fine silt and clay particles. They cited Everest et al. (1987) in stating that there seems to be a broad middle ground between too much and too little sediment in salmonid habitats.

* Review of available documentation and professional observation and conjecture lead to the conclusion that the level of fine sediment loading is above or at the upper limit of natural range of variability in the following FPU's:

Lower Entiat	Lower Mid-Entiat
Lower Mad	Mud Creek
Stormy-Potato	Brennegan-Preston
Roaring-Tamarack	Mills-Dinkleman

* The Lower Mid-Entiat is the most significant sediment storage catch basin in the entire subbasin.

* Mud Creek is the second most significant sediment storage catch basin.

* The two largest tributary systems, Mad River and North Fork Entiat, are sediment transport systems where, based on present knowledge, accelerated erosion and fine sediment deposition in fish habitat are not considered to be problems.

Table F-9-1-1. Analysis Data Used to Stratify Subwatersheds (FPUs)

Subwatershed	Tributaries	Rch	Location	Class	Grad	Embed?	Stream Survey	Comments
Lower Entiat River			RM 0 - 17.5	AA		U	NRCS 1995 srvy	17% fines <1mm 1993
							on private land	16% fines <1mm 1994
								18% fines <1mm 1995
	Mills Canyon Cr	1	0 - 3.0	III		Y	PFC-BLM 1995	very high % fines
	Dinkelman CynCr	1	0 - end	III		U	no	1989 debris flow
	Crum Canyon Cr.	1	0 - end	IV		U	no	hi surface fines
Roaring Creek		1	0 - 4.2	II	4.5%	Y	level II, 1993	sed appears high
		2	4.2 - 5.1	II	12.3	Y	"	1989 debris torrent
		3	5.1 - 10.2	II	6.3	Y	"	extremely hi % fines
	Tamarack Cr.	1	0 - 3.6	II	9.4	Y	level II, 1993	high % fines
		2	3.6 - 5.7	II	8.6	Y	"	very high % fines
	Sourdough Cr.	1	0 - end	III		U	no	
Mad River		1	0 - 4.3	I	3	Y	lvl II,73,90,95	19% fines <1mm 1995
		2	4.3 - 9.7	I	5	N	"	moderate bank erosin
		3	9.7 - 14.3	I	4	Y	level II, 73,90	some bank erosion
		4	14.3 - 18.8	I	3	N	"	bank erosion common
		5	18.8 - 23.1	I	2	N	"	side slope erosion
		6	23.1 - 23.9	I	1	N	"	sedimnt storage area
		7	23.9 - 25.8	I	2	N	level I, 1990	
	Tillicum Cr.	1	0 - 2.3	II	5	Y	level II, 1992	high sediment load
		2	2.3 - 3.9	II	14	Y	"	fines dominant
		3	3.9 - 5.6	II	3	Y	"	fines dominant
	Kloochman Cr.	1	0 - 2.7	III	13	Y	level II, 1992	sand subdominant
	Medicine Cr.	1	0 - 3.7	III	10	Y	level II, 1992	sand subdominant
	Indian Cr.	1	0 - 4.5	III	12	Y	level II, 1992	
		2	4.5 - 5.8	III	16	N	"	
	Hornet Cr.	1	0 - 2.6	II	10	Y	level II, 1992	
		2	2.6 - 4.9	II	10	Y	"	
	Wilma Cr.	1	0 - end	III		U	no	
	Alma Cr.	1	0 - end	III		U	no	
	Miners Cr.	1	0 - 2.6	III	8	N	level II, 1995	
		2	2.6 - 4.4	III	2	Y	"	sand dominant
		3	4.4 - 4.8	III	3	Y	"	sand dominant
	Blue Cr.	1	0 - end	III		U	no	
	WhistlingPig Cr	1	0 - end	III		U	no	
	Jimmy Cr.	1	0 - end	III		U	no	
	Berg Cr.	1	0 - end	III		U	no	
	Cougar Cr.	1	0 - 0.6	II	5	N	level II, 1991	
		2	0.6 - 4.4	II	8.4	Y	"	hi fines from FR5700
	Billy Cr.	1	0 - 0.6	II	6	Y	level II, 1995	
		2	0.6 - 3.3	III	9	Y	"	
	Young Cr.	1	0 - 1.6	II	6	Y	level II, 1995	hi potential to
		2	1.6 - 2.4	III	6	Y	"	deliver fines to
		3	2.4 - 3.5	III	11	Y	"	Mad River
	Windy Cr.	1	0 - 3.4	III	20	Y	level II, 1994	
Mud Creek		1	0 - 0.3	III	4.4	Y	BLS lvl II 1993	very hi % of fines
		2	0.3 - 2.7	III	3.8	Y	"	hi bankcutting/sed
		3	2.7 - 4.3	III	1.9	Y	"	"
		4	4.3 - 6.8	III	2.1	Y	"	"
	S. Fork Mud	1		IV		U	no	
	N. Fork Mud	1		III		U	no	
	Harris Canyon	1		IV		U	no	
	Murdock Gulch	1		IV		U	no	
Potato Creek		1	0 - 0.6	III	2.8	Y	BLS lvl II 1993	hi % of fines
		2	0.6 - 3.2	III	5.3	Y	"	significant sediment

Subwatershed	Tributaries	Rch	Location	Class	Grad	Embed?	Stream Survey	Comments
		3	3.2 - 3.7	III	12.6	Y	"	"
		4	3.7 - 4.3	III	8.0	Y	"	
	N. Fork	1		III		U	no	
	Gene Cr.	1		IV		U	no	
Middle Entiat River		1	17.5 - 23.5	I	3	Y	lvl II, 1990,94	22% fines <1mm 1993
RM 17.5 to Cttnwd CG		2	23.5 - 29.0	I	3	Y	"	23% fines <1mm 1994
								21% fines <1mm 1995
		3	29.0 - 30.3	I	3	N	"	17% fines <1mm 1993
		4	30.3 - 32.9	I	4	N	"	15% fines <1mm 1994
								15% fines <1mm 1995
		5	32.9 - 35.1	I	2	N	"	15% fines <1mm 1993
		6	35.1 - 38.1	I	3	N	"	16% fines <1mm 1994
								13% fines <1mm 1995
		7	38.1 - 39.3	I	3	N	"	
	Roundy Creek	1	0 - 0.4	III	3	U	BLS lvl II,1993	high % of fines
		2	0.4 - 1.0	III	16	U	"	very hi % of fines
	Tyee Creek	1	0 - 0.25	III	7	U	BLS lvl II,1993	hi% sed & bankcuttng
		2	0.25 - 0.4	III	53	U	"	moderate bankcutting
		3	0.4 - 1.2	III	18	U	"	very low bankcutting
		4	1.2 - 1.7	III	12.5	U	"	mod hi % sediment
	Shamel Creek	1	0 - 0.5	III	13.3	U	BLS lvl II,1993	hi% sed & bankcuttng
		2	0.5 - 1.2	III	27.5	U	"	no bankcutting
		3	0.5 - 1.1	III	27	U	"	mod hi bankcutting
		4	1.1 - 1.3	III	40	U	"	no bankcutting
	Stormy Creek	1	0 - 2.5	I	3	Y	level II, 1990	sed appears a problm
	Dill Cr.	1	0 - end	III		U	no	
	Preston Cr.	1	0 - end	II		U	no	3M T/Y gross sed 79
	Burns Cr.	1	0 - end	II		U	no	5M T/Y gross sed 79
	McCree Cr.	1	0 - end	II		U	no	5M T/Y gross sed 79
	Brennegan Cr.	1	0 - end	II		U	no	5M T/Y gross sed 79
	Grandma Cr.	1	0 - end	III		U	no	5M T/Y gross sed 79
	Mott Creek	1	0 - end	III		U	no	5M T/Y gross sed 79
	Fox Creek	1	0 - end	III		U	no	3M T/Y gross sed 79
	Tommy Creek	1	0 - 2.4	II	12	N	level II, 1992	1990 SRF road-relatd
		2	2.4 - 4.6	II	11	N	"	90 SRF non-road rltd
		3	4.6 - 5.5	II	16	N	"	
		4	5.5 - 6.4	II	21	N	"	
	Silver Creek	1	0 - end	II		U	no	
	Jungle Creek	1	0 - end	III		U	no	
	Pope Creek	1	0 - end	II		U	no	5/95 SRF onto fan
Lake Creek		1	0 - 3.2	II	14	Y	level II,1991 &	sand dominant substr
		2	3.2 - 5.5	II	3.2	Y	"	fines appear high
		3	5.5 - 6.1	II	9.6	N	BLS lvl II 1993	fines appear ok
	Section 32 trib	1	0 - 1.2	III	18.7	N	BLS lvl II 1993	% fines hi above RM1
N. Fork Entiat River		1	0 - 2.0	I	10	N	level II, 1992	
		2	2.0 - 3.0	I	3	N	"	
		3	3.0 - 6.5	I	4	N	"	
		4	6.5 - 9.0	I	9	N	"	
	Crow Cr.	1	0 - end	II		U	no	
	Sheep Cr.	1	0 - end	II		U	no	
	Butte Cr.	1	0 - end	II		U	no	
	Corral Cr.	1	0 - end	II		U	no	
	S. Pyramid Cr.	1	0 - 2.6	II	8.4	Y	level II, 1993	activly erodng banks
		2	2.6 - 5.8	II	8.6	Y	"	extreme downcutting
	Grouse Cr.	1	0 - end	II		U	no	
Upper Entiat River		8	39.3 - 42.2	I	2	N	level II, 1992	

Table F-9-I-1. **Analysis Data Used to Stratify Subwatersheds (FPUs)** - Continued

Subwatershed	Tributaries	Rch	Location	Class	Grad	Embed?	Stream Survey	Comments
		9	42.2 - 43.8	I	3	N	"	
		10	43.8 - 47.1	I	2	N	"	Wilderness Boundary
		11	47.1 - 52.0	I	3	N	"	
		12	52.0 - 54.5	I	5	N	"	
	Duncan Creek	1	0 - end	II		U	no	
	Three Creek	1	0 - 1.4	II	18	Y	level II, 1992	some bankcutting
		2	1.4 - 4.1	II	17	Y	"	
	Anthem Creek	1	0 - end	III		U	no	
	Choral Creek	1	0 - end	III		U	no	
	Snow Brushy Cr.	1	0 - 1.4	II	7	Y	level II, 1993	% fines appear ok
		2	1.4 - 5.0	II	8	Y	"	no bank erosion
	Aurora Creek	1	0 - end	III		U	no	
	Pinnacle Creek	1	0 - end	III		U	no	
	Candy Creek	1	0 - end	III		U	no	
	Cool Creek	1	0 - end	III		U	no	
	Ice Creek	1	0 - 4.2	III	8	Y	level II, 1993	
	Pomas Creek	1	0 - end	III		U	no	
	Larch Lakes/Cr.	1	0 - end	II		U	no	
	Cow Creek	1	0 - end	III		U	no	
	Myrtle Lake/Cr.	1	0 - end	II		U	no	
	Garland Creek	1	0 - end	III		U	no	
	Shetipo Creek	1	0 - end	III		U	no	

PFC/BLM = Proper Functioning Condition
SRF = Shallow Rapid Failure
Embed?: Y = Yes, visually estimated cobble/grvl embeddedness >35% by volume
N = No, " " " <35% "
U = unknown
T/Y = est annual average gross sediment production in tons per yr from 1979 ECRBS

APPENDIX II

Landscape Setting - Geology and Landtype Associations
Entiat and Mad River Watersheds and Columbia River Tributaries

The following narrative was excerpted from the funding request form for Burned Area Emergency Rehabilitation for the 1994 Tyee Fire:

"The upper portions of the FPU's are steep with alluvial fans on lower slopes. Flooding upon these alluvial fans is a natural process. Management of these areas is primarily the responsibility of the Forest Service, Bureau of Land Management, and the Washington Department of Natural Resources.

Alluvial fans are in private ownership. Approximately two to five homes are located on each alluvial fan. Many alluvial fans have high quality apple orchards with expensive storage warehouses. There are more than two dozen of these alluvial fans located in the Entiat Valley alone.

Burn intensities from the 1994 wildfires ranged from moderate to high in the upper portions of the FPU's. Hence, much of the vegetation has been removed from these watersheds.

The FPU's are in the rain shadow of the Cascades. Within a span of less than 50 miles, from the mouth of the Entiat River to its source, precipitation ranges from 10-90 inches.

Wildfire occurrence in the lower postions of the subbasin is high. Since 1970, at a recurrence interval of approximately every six years, there has been a wildfire followed by major flooding one to two years afterward. Records indicate that as much as one to two inches of rain have occurred in less than one hour. Given the burned conditions, extensive flooding occurred. Four fatalities occurred with one of these floods. Given the size and scale of the 1994 fire, the risk to life and property from flooding is extremely high.

Lower watershed valley bottoms become quite constricted just above the gentle sloping alluvial fans. These constricted locations become the site of debris dams which blow out with tremendous force and little warning.

Roads entering FPU's parallel within 300 feet of stream channels. All roads dissect alluvial fans in valley bottom positions. Without drainage improvements these roads will washout adding significantly to debris deposition to narrow stream channels. With the amount of debris generated, debris jams are extremely probable."

The following information provides more background in support of the LTA interpretations in the text of the SWF report:

GEOLOGIC AND GEOMORPHIC BACKGROUND

Introduction

The Entiat River watershed has been stratified into four landtype associations. These landtype associations have distinctive features and ecologic processes. The purpose of this summary is: 1) to provide a generalized history of the geology and geomorphic processes which control landscape patterns; and 2) to briefly describe these associations in terms of key features which effect ecological functions and processes.

Geologic Bedrock

The Entiat River watershed encompasses all or part of four geologic terrains. A geologic terrain is defined by a sequence of rock units and/or structural history which is distinctly different from adjoining terranes. Physiographic boundaries of the Entiat River watershed, bedrock units and faults and folds within the watershed generally follow the regional northwest trending geologic structure. The four terrains mapped within the Entiat watershed include; the Swakane, Mad River, and Chelan Mountains terrains and the Duncan Hill pluton. Geologic discriptions and history included here are based on mapping and compilation done by Roland Tabor of the USGS.

Bedrock of the Swakane terrain is primarily the Swakane Biotite Gneiss. It is generally fine to medium grained and somewhat schistic. It occurs mainly in the south southeastern portion of the watershed. Light colored dikes and sills are present especially along an anticlinal fold which extends up Swakane Creek. This rock unit is believed to be formed from sediments eroded from granitic bedrock over 690 million years ago. Fracturing along bedding planes, joints, and the platey texture allows water to infiltrate deep into the rock, increasing the weathering and erodibility of this unit.

The Mad River terrain is located in the south central portion of the watershed. It begins as a narrow band at the Columbia River near Keystone Gap and extends northwest to the headwaters of the Entiat. It follows the Entiat fault zone north of the headwaters of Swakane Creek. It is primarily a quartz schist and light colored gneiss. Talc, graphite and serpentine occur locally. These minerals increase the deep seated slope failure hazard in some areas. It is cut by light colored dikes. The Mad River terrain is a metamorphic bedrock that was derived from volcanic sediments and rock deposited between 250-700 million years ago.

The Chelan Mountain terrain consists of three different rock units: the Entiat pluton is most prominent in the central portion of the watershed; a banded gneiss is located in the headwaters; and a migmatite (a light and dark colored gneiss with a swirled appearance) runs along the northeast boundary with the Chelan Ranger District. The Entiat pluton is granitic with the exception of the Potato and Stormy Creek areas, where the bedrock is mapped as a gabbro (a dark colored intrusive igneous rock which is low in silica). All three units are described as being streaked, swirled, schistose, or irregular in places and high in magnesium and iron, which indicates a high degree of fracturing and associated weathering.

The Duncan Hill pluton is the youngest of the terrains mapped. It is a light-colored granodiorite with biotite and hornblende. It occurs along the north central and northwestern portion of the watershed (including and to the west of Stormy Mountain). It is moderately jointed and overall is relatively resistant to weathering.

Rhyolite dikes occur in the vicinity of Mud Creek. Various silts and upland gravels and debris flow deposits cap ridges in the Miners, Medicine, Moe and Roaring Creek areas. Similiar deposits also occur in the Johnson Ridge area. Composition and sources of these deposits vary. These are evidence of an inverted topography and can be useful to correlate rate of channel incision since their deposition in the Pliocene (2-5 my). Pumice and ash

mantle bedrock and soils in the western portion of the area. Ash and loess mantle or are mixed in soils in the eastern portion of the watershed.

Geologic Structure

The Entiat Fault zone is the major fault which occurs in the area. It trends northwest from Birch Mountain to Phelps Creek at the headwaters of the Chiwawa River on the Lake Wenatchee District. An anticlinal fold runs along Swakane Creek in the southeastern portion of the District. A number of shorter folds and faults occur within the Mad River terrain. An east-west trending fault extends from Billy Ridge, through Tyee Ridge and up Stormy Creek. Metamorphic rock at the headwaters of the Entiat have a high density of randomly-oriented faults. Jointing occurs throughout the area.

The main influence of faulting and to a lesser extent folding, is increased fracturing of bedrock which results in deeper percolation of ground water. Seeps and springs are often associated with faulting and fracturing. Subsurface water may contribute to soil creep in areas. Deep-seated slope failures in the upper Entiat and Mad River areas were in part triggered by post-glacial climatic conditions or earthquakes. Swakane Creek follows the axis of folded bedrock for most of its length. The Entiat and Mad Rivers largely follow the northwest trending regional structural.

Geomorphic Background

Glacial and volcanic activity were important to landform characteristics in the upper Entiat and Mad River watershed. Bill Long, former Forest Service Geologist has identified evidence of two episodes of glaciation in the Entiat watershed; one from 150,000 to 130,000 and one from 20,000 to 13,000 years ago. The greatest extent occurred during the second episode, when glaciers advanced down the upper Mad River. Much of the area is mantled by volcanic ash with or without pumice deposited from two major eruptions; Glacier Peak dated at 11,200 and Mazama dated at 6,700 years ago. Numerous smaller eruptions have occurred over time. These volcanic deposits contribute to a high surface erosion hazard in most of the area.

Glaciation has significantly influenced the landform and geomorphic processes which characterize the Entiat watershed. The upper valley is a typical U-shaped glacial trough with oversteepened glacially scoured slopes. Upper sideslopes and angular ridges are rocky with weakly developed soils. Numerous cirques are carved into these ridges. Mid- to lower slopes are mantled with poorly sorted glacial till. Valley bottoms are relatively broad and blanketed with till and glacial outwash deposits. Characteristics of these landforms in large part define the hydrologic regime, mass wasting hazards, and fluvial processes in the watershed. Debris flow hazards are high where glacial tills are deposited on steep slopes. Numerous debris slides have originated in these deposits, delivering sediment and large woody debris to streams and alluvial fans. Several collapsed glacial till deposits were mapped in the upper Mad River.

Landtype Association Stratification and Description

Four landtype associations are mapped within the watershed analysis area. The area covered by each terrane is shown on the accompanying map. For each landscape terrane a brief description of site features, interpretation of dominant geomorphic processes, and the resulting ecological conditions and processes is provided below along with an example of representative areas and dominant landform(s).

LTA A: TROUGH HEADWALLS AND CIRQUE BASINS:
This association consists of extremely steep, rocky peaks and ridges which form the headwalls of U-shaped glacial valleys and the gently sloping cirque basins carved into these headwalls by glaciers. Trough headwalls and cirque basins display different hydrologic characteristics and ecosystem process-

es. This association comprises roughly 11 percent of the watershed and is associated with LTA B, glacial troughs.

Trough headwalls have excessive bedrock outcrops which form numerous cliffs and ledges. Avalanche chutes, rock slides and talus slopes are common. Glacial till is usually absent and soils are shallow. The slopes are dissected by a low to moderate density of high gradient, weakly incised,low order, intermittent streams in a parallel drainage pattern. Subsurface water storage is low and delivery of surface runoff to streams and lower slopes is rapid. Rapid runoff decreases regulated streamflow and increases the slope stability hazard of glacial tills on lower slopes. This landform is normally above timberline but may support grasses and shrubs.

Cirque basins are low gradient, semi-circular or elongate features. The basin floor has an undulating relief formed of glacially-scoured knolls and depressions which contain wet meadows. Very steep rocky slopes arc around the basin with talus accumulated at the base. The outlet typically has a rock lip referred to as a threshold. Small lakes, seeps and springs are common. Poorly-defined intermittent or perennial streams form a deranged drainage pattern. Cirques have a high water storage capacity. Runoff is low in contrast to the surrounding headwalls. Surface erosion hazard is low to moderate and compaction hazard is high. Landscape position and climatic, and subsurface and surface water conditions may provide unique wildlife habitat and vegetative communities. Cirques are an important source of baseflow regulation in late season. High compaction hazard and interception of subsurface flow by trails are management concerns.

LTA B1: GLACIAL TROUGHS MANTLED BY PUMICE:
This landtype consists of broad valley floors and steep sideslopes of U shaped glacial valleys. Lower and mid slopes are typically mantled with glacial till and avalanche debris. Alluvial fans are common along valley margins. Sideslopes are generally concave at the base and straight on the upper slopes. Slopes range to 90 percent. In the Entiat watershed this landtype is mantled with pumice and ash. It makes up roughly 16 percent of the watershed.

Slopes are dissected by weakly incised, low order streams in a parallel drainage pattern. Channel gradients are high. Subsurface water storage capacity is relatively high in the glacial till deposits. Seeps and springs are common, especially along drainages. Shallow subsurface flow can be rapid where deep pumice overlies glacial till. Surface runoff is moderate to relatively low, depending on depth of pumice. Soils formed in pumice and volcanic ash are highly erodible. Interception of subsurface flow by roads increases shallow rapid failure and surface erosion and delivery hazard. Slope stability hazard is high, with snow avalanches common at upper elevations and debris flows originating in glacial till. Steep slopes, moderately high subsurface water storage and the rapid surface runoff and delivery from trough headwalls and rock outcrops contribute to the high hazard.

LTA C2: GLACIATED MOUNTAIN SLOPES MANTLED BY VOLCANIC ASH AND PUMICE:
This association consists of mountain slopes and ridges modified by glacial and/or periglacial activity. Much of this landtype lies on high elevation benches interpreted to be remnants of an ancient erosional surface. Relief between secondary drainage bottoms and spur ridges is relatively low with slopes commonly less than 40 percent. Drainage bottoms are broadly concave and ridges are weakly convex. Glacial till is usually present on drainage bottoms and benches but can occur on side slopes. A mantle of pumice and ash is typical. As mapped, this unit makes up 35 percent of the Entiat watershed.

Slopes are dissected by a moderate density of weakly incised streams in a dendritic pattern. Channel gradients are low to moderate. Subsurface water storage is moderately high due to non-compacted glacial deposits and a deep mantle of soil and weathered bedrock. Water storage is reduced on ridges and where bedrock is close to the surface. Seeps, springs and wet meadows are common along drainages, swales and basins. These are important to baseflow regulation and may provide unique

habitat. Surface runoff is generally low. Pumice soils are very well drained with low water holding capacity and may be difficult to revegetate once finer textured soil at the surface is disturbed. Effects of roading such as oversteepening of sideslopes, interception of subsurface flow, unstable cut and fillslopes and increased surface erosion and mass wasting hazards, particularly at channel crossings are a management concern.

LTA E: MOUNTAIN SLOPE LANDFORMS

This landtype association occurs on low and mid elevation mountains in the eastern portion of the watershed. It is comprised of non-glaciated, mountain and strongly dissected mountain slopes. Relatively narrow convex ridges, deep shoulders and steep, narrow V-shaped fluvial valleys are characteristic. Deep soil mantles on ridges were formed by freeze and thaw action in a periglacial setting. Slopes most commonly range from 30-60 percent but slopes exceeding 60 percent are typical along higher order rivers. LTA E makes up 35 percent of the watershed and includes the Columbia River Tributaries.

These mountain slopes are dissected by a relatively high density of moderately to deeply-entrenched streams in a dendritic to pinnate pattern. Channel gradients are moderate to steep. Subsurface water storage is low and surface runoff is rapid on side slopes and moderate on ridges and colluvial swales. Streams often originate at seeps and springs which emerge at the base of ridge shoulders. These springs are believed to largely be relics of periglacial processes and climatic conditions and are not regularly recharged under current climatic conditions.

Soils formed mainly in volcanic ash and loess mixed with or overlying moderate to coarse-textured soils weathered from gneiss, schists and granites. LTA E has high soil moisture stress due to well-drained subsoils, rapid runoff and low annual precipitation. Management concerns include: compaction due to grazing and tractor logging; effects of roading on steep side slopes (unstable cut and fillslopes); increased surface erosion and delivery hazards particularly at road channel crossings, and channel confinement in narrow v-shaped valleys. Accelerated mass wasting is a concern following fire. Deep seated slope failure hazard is locally a concern, primarily in the Tillicum, Indian and Windy Creek areas.

LTA H: VALLEY BOTTOM LANDFORM

This unit consists of relatively narrow, gently sloping alluvial deposits bordering mountain and valley streams. It includes floodplains, low terraces and alluvial fans. Colluvial deposits may occur at the base of steep slopes along the valley margin. Alluvial fans are common at the mouths of tributary streams. Fan substrate includes alluvial deposits as well as unsorted fine and coarse material deposited by debris flows. Stream channels on the fan surface are unconfined and are easily diverted from their course. Though it comprises only one percent of the watershed area, this landform is extremely important for water quality and riparian values: It provides a buffer between streams and hillslope erosion and mass wasting processes, has a high water table favorable to riparian vegetation, and in places may provide subsurface flow to the margins of riparian zones. Flooding and debris flows are natural processes which can pose a hazard to life and property in these areas.

APPENDIX III

Definition of Data Elements Used in Analysis of FPUs

Each of twenty FPU's within the Entiat Analysis Area were evaluated by a number of data elements. Definitions of these elements follow.

FPUs - "Fish Production Units" as delineated in Forest Land Management Plan.

Transport or Depositional - Professional evaluation as to how the system within a given FPU handles the fine sediment load. "Transport" reaches tend to move incoming fine sediment on through the reach, while "Depositional" reaches tend to store incoming material.

Dominant Vegetative Type - Visual estimate of dominant veg type using a PMR based plant association map. "High elevation" = mountain hemlock/ sub-alpine fir.

Grazing Intensity - Estimation of the grazing intensity within a given FPU based on historical grazing records and using the following criteria:

HIGH
*Extended grazing season
*Rolling topography
*Ponderosa pine - grass interface
*CATTLE DOMINANT

MODERATE
*Moderate-length grazing season
*Steep slopes
*Subalpine fir forest setting
*SHEEP DOMINANT

LOW
*Short grazing season
*Steep slopes
*High elevation

Slope Delivery Efficiency - Denoted by a relative ranking (H-M-L). This parameter was developed by evaluation of a number of factors that influence the delivery of eroded material (slope, drainage density, etc.)

Stream Density - Miles of stream per square mile of FPU, as determined by GIS report (perennial and mapped intermittent channels only).

Acres of Alluvial Fan - Acres of alluvial fan, as mapped within the boundaries of the Tyee Complex Fire. Data were not available for FPU's outside the fire boundary. Data tables list "NA" for this element in these FPU's.

Road Density - Miles of road per square mile of FPU.

Roads within 300' channel - Miles of road within 300 feet of a perennial or intermittent stream channel.

Burn Intensity - Percent of the FPU burned at moderate or high intensities in the 1994 wildfire.

Average Annual Precip - Average annual precipitation within the FPU.

Area for each FPU - Total acres.

APPENDIX IV

Grazing Assessment - Entiat Subbasin

HISTORICAL STATUS

According to records and interviews, grazing began in the Entiat subbasin in the early 1890's. Grazing from the 1890's until approximately 1920 was essentially unregulated meaning that there were no restrictions on the numbers or season of use. As more people settled in the Entiat Valley, every rancher had cattle and horses which grazed at will. Based upon records and interviews, the level of grazing was very heavy. Type, numbers, season of use and location are shown in the following table.

Type of Livestock	Quantity	Season of Use	Area Grazed
Sheep	13,000-50,000	8 Months	Entiat Watershed
Cattle	1,000	Year Long	Entiat Valley
Cattle	1,000-12,000	8 Months	Mud Creek Area
Dairy Cows	100+	8 Months	Entiat Valley
Horses	400	Year Long	Entiat Foothills
Hogs	150	Unknown	Entiat Foothills

As stated, the level of grazing shown above was unregulated. According to records, large bands of sheep gathered near the old Entiat townsite and trailed up Dick Mesa as soon as the snow melted. These sheep continued to graze the ridges all the way to Entiat meadows in the headwaters of the Entiat subbasin. These sheep were not herded back out of the mountains until snow fall, likely in late October or early November. Also according to interviews with Albert "Shorty" Long (1994) a longtime historian of the Entiat, the grazing strategy used was first come, first served.

While the sheep were grazing the upper ridges, cattle and horses were grazing the Entiat Valley and adjoining foot hills which included the Mud, Potato, and Crum Creek drainages. Again the season of use was approximately 8 months. Based upon interviews, the grazing started soon after snowmelt and continued until snow fall in early November. It was common for local ranchers to graze their unused horses in the Foot Hills of the Entiat subbasin. These horses multiplied and became a local wild horse herd. Ranchers began relying upon this local wild horse herd for riding stock and extra money during hard times. This horse herd essentially grazed year long in the Entiat Valley and adjoining foot hills.

Many of the early day ranchers kept small dairy herds which grazed in the Entiat and tributary valleys. This was local grazing in the Entiat Valley and a short distance up tributary streams. Also records indicate that hogs were grazed in the Entiat Valley and adjoining foothills.

Beginning about 1928, the Forest Service began acquiring lands in the Mud, Morical, and Crum watersheds. With the consolidation of private lands into Forest Service ownership, grazing started to be regulated. It is very likely that during the 1930's, the Forest Service began to reduce the level of livestock grazing due to watershed concerns.

EFFECTS OF HISTORICAL GRAZING

The magnitude of early day grazing in the Entiat Drainage was likely responsible in part for a number of significant resource conditions.

Riparian: The extended grazing season would have been very hard on riparian shrubs. Due to the hot summers and limited water, livestock would have concentrated in riparian bottoms. Low and mid level shrubs would loose their vigor with heavy late season grazing. Desirable perennial grasses would be replaced with less desirable species. Tall shrubs would become hedged. Stream banks would have been eroded. The desirable perennial grass species would be replaced by less desirable species and eventually annuals and noxious weeds. Moist areas are more susceptible to compaction which leads to reduced infiltration and aeration of the soil and increased surface runoff and erosion. Sediments produced in riparian areas are easily delivered to the stream. Platts (1981) stated streams impacted by grazing are typically shallower, wider, warmer with less overhead cover. No grazing system in riparian areas is able to maintain a better than fair rating on quality instream habitat (cited in Gillen et.al, 1985).

Lower Entiat Area (Sediment Depositional Areas): Grasses in this area normally greened up early and would have fall sprouting (tillage) in the fall. Repeated early and late grazing would have lowered the vigor of bunch grasses and other desirable grasses. With continued use during the summer and fall, bunch grasses would have drastically declined and plants such as cheat grass would have increased. Also the wintering horses tend to pull grasses root and all out of the soil. With the level of grazing on record, the grassy understories common to this area would have been drastically reduced allowing accelerated surface erosion. The existing surface volcanic ash on many of these slopes is very thin or non-existent. The degraded soil surface became a very suitable seed bed for ponderosa pine and Douglas-fir encroachment. Many of the pole size understory trees are from 60 to 70 years old which dates back to the decline of grazing pressure and the increased fire suppression in the 1930s.

Upper Entiat Area (Sediment Transport Areas) The sheep trailing along the upper ridges would have left a network of trailing terraces. The existing grassy understory has become aligned with the terracing which has develop parallel strips of vegetation separated by non-vegetated terraces. Bedding and nooning grounds would become sites filled by undesirable antenaria spp.

MANAGEMENT IMPLICATIONS

The biggest effect from grazing will be the vegetative composition of the riparian vegetation, compaction of the topsoils, and the loss of top soils on south facing slopes.

Riparian: Vegetation structure of the riparian could be low in low to mid-level shrubs. Tall shrubs could be decadent.

Lower Entiat Area (Sediment Deposition Areas): The loss of vegetative cover and disturbed soil condition would have created excellent seed beds for tree seedlings. With the decrease of grazing in the 1930's and the increase in fire suppression, many of these tree seedlings survived creating relatively dense pole stands. These sites historically rarely supported this level of trees. With the resulting high intensity fire, surface erosion will again be high on these south facing slopes. Because the soil condition has changed (loss of top soil), it may be difficult to establish grassy understory. Without a vigorous grassy understory, it may be difficult to use under-burning as a tool to maintain parklike stands of ponderosa pine and Douglas-fir.

Upper Entiat Area (Sediment Transport Areas): Old sheep bedding grounds will be supporting heavier concentrations of undesirable forbs than that which occurred naturally. Old sheep trailing areas will likely still manifest evidence of soil compaction which will limit understory composition.

General Effects of Grazing

Literature indicates that grazing can increase soil bulk density, which in turn can reduce infiltration, increase surface runoff and reduce available soil water. This is especially true when livestock grazing is concentrated or when soil conditions are moist. As bulk density increases, the larger soil pores which store available water and

nutrients decrease. The extent of these alterations, along with loss of organic matter, affect soil recovery (Childs, 1989; see following section).

According to historical records, grazing in the analysis area prior to 1930 was essentially unregulated. This unregulated grazing led to concentrated grazing at times when soil conditions were moist. It is expected that soil conditions were likely adversely effected during this period.

Current grazing strategies limit grazing until after soil conditions are dry and emphasize dispersed grazing. Areas of concern will be livestock travel routes in the Mosquito Ridge Allotment and livestock concentrations in valley bottoms in the Potato Creek Allotment. These areas of concern will need special administration emphasis to reduce adverse effects to soils and vegetation.

Soil Recovery Processes

Processes which are important to the recovery of a compacted soil include; effects of freeze and thaw action, faunal activity, stresses of root growth and wetting and drying cycles. Mixing of soil due to soil creep and tipping of trees with roots attached also reduce compaction. Increase in organic matter is important to a soils ability to recover from compaction. Additional loss of organic matter in a compacted soil furthur delays recovery. Due to greater organic matter and freeze and thaw action under moister conditions, the recovery rate from compaction is delayed in environments that are moisture stressed and increases where moister conditions exist.

Linda Hardesty in a draft report on the characteristics of future rangelands on the Tyee Creek and Hatchery complex fires (unpublished, 1996) indicated vegetation may be altered in areas intensively burned. Soil loss and loss of nutrients and organic matter were primary reasons and seeding as a rehab measure and spread of noxious weeds were secondary reasons for alteration. It was suggested that existing herbage on the sites be reserved for soil recovery processes including; surface protection and building organic matter and nutrients. Controls on season of use and distribution may offer some possibilities for limited grazing to contribute to overall resource management goals.

APPENDIX V

Comparison of 1930'S Bureau of Fisheries Pool Observations to 1990'S Forest Service Pool Observations

Entiat River

A U.S. Bureau of Fisheries (BOF) survey was conducted on the mainstem Entiat and Mad Rivers during 1935-37. The methodology included the systematic collection of information on pool and substrate characteristics. "Station locations" (1930's) and "reach breaks" (1990's) which identify river segments have been grouped where the start/end points are similar. Similar river segments are displayed "side-by-side" in this table. Where river reaches were combined, the pool observations were weighted according to length of the reach to obtain an overall estimate of large pool frequency.

Mainstem Entiat River Pool Frequency Comparisons

Parameters	1935 - 1937 Entiat	1990's Entiat	% Difference
Survey section Length (mi) Pools/mile*	Stations 1-6 8.1 miles 6.7 pools/mile	NO SURVEY	DEPOSITIONAL ZONE
Survey section Length (mi) Pools/mile	Station 6-7 4.3 miles 1 pool/mile	NO SURVEY	DEPOSITIONAL ZONE
Survey section Length (mi) Pools/mile	Station 7-8 5.0 miles 19 pools/mile	NO SURVEY	DEPOSITIONAL ZONE
Survey section Length (mi) Pools/mile*	Station 8-9 6.3 miles 6 pools/mile	Reach 1 (94) 6.0 miles 0.49 pools/mi	DEPOSITIONAL ZONE -92%
Survey section Length (mi) Pools/mile	Station 9-10 8.4 miles 4 pools/mile	Reaches 2,3 & (.8) of R4 8.8 miles 1.62 pools/mi	TRANSITIONAL ZONE -60%
Survey section Length (mi) Pools/mile	Station 10-11 2.9 miles 3 pools/mile	(.2) R4 and R5 2.7 miles 2.07 pools/mi	TRANSITIONAL ZONE -31%
Survey section Length (mi) Pools/mile	Station 11-12 4.3 miles 2 pools/mile	Reaches 6 and 7 4.2 miles 2.16 pools/mi	TRANSPORT ZONE +8%
Survey section Length (mi) Pools/mile	Station 12-13 3.5 miles 4 pools/mile	R1 and R2 (1992) 4.5 miles 5.1 pools/mi	TRANSPORT ZONE +28%
Total Mileage	**42.8 miles**	**42.5 miles**	

* BOF counted "Resting Pools" which are large pools greater than or equal to 25 square yards and depth >2 feet. Recent surveys (1990's) count large pools, which are longer than channel width. The two sets of data are comparable for the mainstem Entiat.

Comparison of 1930'S Bureau of Fisheries Pool Observations to 1990'S Forest Service Pool Observations

Mad River

A U.S. Bureau of Fisheries (BOF) survey was conducted on the mainstem Entiat and Mad Rivers during 1935-37. The methodology included the systematic collection of information on pool and substrate characteristics. "Station locations" (1930's) and "reach breaks" (1990's) which identify river segments have been grouped where the start/end points are similar. Similar river segments are displayed "side-by-side" in this table. Where river reaches were combined, the pool observations were weighted according to length of the reach to obtain an overall estimate of large pool frequency.

Mad River Pool Frequency Comparisons

Parameters	1935 - 1936 Mad River	1990 Mad River	% Difference
Survey section Length (mi) Pools/mile	Mouth to Station C 4.1 miles 1.6 pools/mile	Reach 1 4.3 miles 7.0 pools/mi	DEPOSITIONAL ZONE +338%
Survey section Length (mi) Pools/mile	Station C-D, D-E 6.0 miles 1 pool/mile	Reach 2 5.4 miles 11.6 pools/mi	TRANSITIONAL ZONE +1,060%
Survey section Length (mi) Pools/mile	Station E-F 5.3 miles 4.0 pools/mile	Reach 3 4.6 miles 7.4 pools/mi	TRANSITIONAL ZONE +85%
Survey section Length (mi) Pools/mile	Station F-G 5.3 miles <1 pool/mile	Reach 4 4.5 miles 3.1 pools/mi	TRANSPORT ZONE +210%
Survey section Length (mi) Pools/mile	Station G-H (Blue Cr) 2.5 miles 4 pools/mile	R5 (Blue Creek) 4.3 miles 0.5 pools/mi	TRANSPORT ZONE -88%
Overall Weighted	2.1 pools/mile	6.2 pools/mi	+195%
Total Mileage	23.2 miles	23.1 miles	

* BOF counted "Resting Pools" which are large pools greater than or equal to 25 square yards and depth > 2 feet. Recent surveys (1990's) count large pools which are longer than channel width. For this comparison only pools greater than three feet in depth that were recorded in the 1990 survey were used in the analysis. The individual reach percentage changes should be utilized only to provide trends, especially in the upper two reaches, where the mileages are different during the two periods.

Notes on Appendix V (1930s vs 1990s Stream Survey Data)

Question: What does "weighting by length of reach for combined reaches" mean?

Explanation: A standard procedure in basic statistics is to weight means when observations are based on different numbers. In this case the length of reaches (miles) varies when comparing the 1930's and 1990's pool quantity data.

Example: In the 1994 survey of Entiat Reaches 6 and 7 the following observations were made:

R6 = 3 miles and had 2.36 pools/mile
R7 = 1.2 miles and had 1.65 pools/mile

In data from the 1930's, a comparable survey was taken from stations 11 to 12 and in 4.2 miles had two pools/mile.

In order to combine the R6 and R7 values into one estimate of pools/mile, they must be weighted according to stream length, which is a superior method of comparison to an arithmetic average. For instance to get an average pools/mile estimate by adding 2.36 pools/mile + 1.65 pools/mile and dividing by 2 would assume equal reach lengths. So...

3 miles = .71 of the combined length (3 miles divided by 4.2)

1.2 miles = .29 of the combined length (1.2 miles divided by 4.2)

These factors (.71 and .29) are then used to come up with an overall pool/mile estimate by **weighted length.**

Overall pools/mile in R6 & R7 = .71(2.36 pools/mile) + .29(1.65 pools/mile)

= 1.68 + .48 = 2.16 pools/mile for the combined reaches.

That number (2.16 pools/miles) can now be compared to the 1930's number of 2 pools/mile for the same length of stream.

Question: "Are there any substrate comparisons between 30's and 90's data"?

Response: No, the data are not comparable due to methodology differences between the surveys. The exception would be gross indicators, which would only show up with extreme shifts in substrate type. Substrate definitions also differ, further compounding the difficulty of comparing two different surveys.

Amy Unthank, Fisheries Biologist, Wenatchee National Forest.

APPENDIX VI

Entiat Watershed Analysis Fisheries Context

INTRODUCTION

Watershed analysis is important to ensuring that aquatic system protection is fitted to specific landscapes and is one of the principal analyses in making decisions on implementation of the Aquatic Conservation Strategy. The Aquatic Conservation Strategy approach seeks to prevent further degradation and restore habitat over broad landscapes as opposed to individual projects or small watersheds.

The Entiat has been identified as part of a system of key watersheds within the range of the northern spotted owl, that serves as critical refugia for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. The Entiat is a Tier 1 Key Watershed which is to contribute directly to the conservation of at-risk fish species. Two anadromous "stocks-at-risk" (FSEIS VOL II/Table B6-5) and a resident bull trout population are found within the Entiat Watershed. Entiat spring chinook and summer steelhead populations are identified as "depressed" by the Washington Department of Wildlife and Fisheries, and additionally, the summer steelhead population was rated at a "high risk of extinction" by Nehlsen et al. (USDA/USDI 1994). Bull trout have been found to be eligible for listing as endangered or threatened by the U.S. Fish and Wildlife Service and are on the Regional Forester's Sensitive Species list.

BACKGROUND

Very little is known of the size of native fish runs in the Entiat before Euro-American settlement. Because the runs were greatly affected by the turn of the century (1900's) both at the local and overall Columbia River scale, most of the evidence to set current objectives relates to the runs as established in the Entiat, and elsewhere in the mid-Columbia, during the Grand Coulee Fish Maintenance Project beginning in the 1940's. Work by Mullan et al. (1992) and others provides evidence that the Entiat supported runs of migratory spring chinook, summer/fall chinook, coho, summer steelhead, and bull trout.

Mullan et al. (1992) presents evidence that the historical (1850's) and current abundance in the Entiat are similar, and that the greatest difference between these periods is the shift in species composition as mid-Columbia coho have reached extirpation, chinook have increased threefold, and steelhead slightly increased.

When the Forest Service signed the Columbia River Basin Anadromous Fisheries Management Policy in 1991, it was recognition of FS support to restore the runs as reflected in laws, documents, and plans of the Northwest Power Planning Council and others (USFS 1991[a]). The Salmon and Steelhead Subbasin Plan for the Entiat (WDF et al. 1990) was integrated into the overall Integrated System Plan (ISP) for the 31 subbasins of the Columbia River (Columbia Basin Fish and Wildlife Authority 1991). The main goal of the ISP was to identify strategies for doubling salmon and steelhead runs in the Columbia from the current 2.5 million (>80 percent hatchery) to 5 million. Historic runs were estimated as 10-16 million, but losses due to hydropower, only, define the 5 million objective.

Spring Chinook

In the ISP the Okanogan, Methow, Entiat, and Wenatchee are considered as the "Upper Columbia" unit. Stock status is depressed for all the natural spring chinook runs in those basins, with the exception of the Okanogan (wild run is extinct), and the hatchery run in the Wenatchee (considered to be healthy). The recent wild adult population in the Entiat averaged 175 from 1986-1995 (based on redd counts, see Figure F-9-VI-1). The 33-year

(1962-1995) average wild adult Entiat population averaged 437 with a maximum of 1344 adults in 1964 and a low of three adults in 1995. Entiat Hatchery spawning escapement has averaged approximately 500 fish per year for the same time period, but has declined to fewer than 100 fish per year in the past two years. The combined wild and hatchery spawning escapement has averaged 675 fish per year from 1980 to 1995, which is ten percent of the ISP escapement goal for spring chinook in the Entiat subbasin. The ISP modeled a total subbasin return to the Entiat of 6,682 spring chinook (hatchery and wild) and a harvest outside the basin of 1,905 spring chinook if recommended strategies to double the runs were implemented. The ISP stated that:

> "The dominant impact limiting anadromous fish production are the (eight) Columbia River dams. Although not an inbasin feature, they remain as major obstacles on the "habitat path" for basin fish and mortality at these projects substantially overshadows inbasin habitat limitations."

The recommended strategy was to improve natural production and utilize supplementation in the basin. Natural production would be improved by additional screening of diversions, decreases in poaching, improved passage at Roundy Diversion dam (McKenzie Irrigation Ditch), passage provided at Box Canyon, reactivation of an artificial spawning channel, and supplementation with 200,000 fingerlings. The McKenzie Irrigation Ditch diversion dam was modified to fully passable at all flows in November, 1994 by a joint project involving the McKenzie Ditch Association, Washington Department of Fish and Wildlife, Wenatchee National Forest, Chelan County PUD, and Yakama Indian Nation.

Summer Chinook

In the ISP Enitiat summer chinook are not considered for stock status or objectives. The ISP stated no escapement goals for Entiat summer chinook although recent (1993-95) spawning survey results indicate that "late-run" chinook spawning is exceeding that of spring chinook. A 1995 spawning survey conducted by the USFWS Mid-Columbia River Fishery Resource Office located 45 late-run chinook and 33 redds between Entiat River miles 16 and 28. The Wenatchee, Methow, Okanogan and Yakima subbasins are considered for natural production, in addition to Wells Hatchery stock production. The Yakima runs are extinct, the other three subbasin runs are rated as depressed, and the hatchery production is considered as "steady".

In June of 1993, a petition was presented to the Secretary of Commerce to list mid-Columbia River summer chinook salmon under the Endangered Species Act, at which time National Marine Fisheries Service (NMFS) began a status review of the mid-Columbia summer chinook. NMFS considered the "mid-Columbia" to be defined as the Okanogan, Methow, Entiat, Wenatchee, and Yakima subbasins, plus the mainstem Columbia between Chief Joseph and McNary dams. The petition considered the mid-Columbia to be defined without the Yakima subbasin or the mainstem Hanford Reach included in NMFS review.

Summer and Fall chinook spawn timing and location overlap, and close genetic similarities exist for mid-Columbia summer chinook and fall chinook from the Hanford Reach and elsewhere in this area (i.e., Wells Dam). Thus, these summer chinook are closely aligned with mid-Columbia fall chinook and not reproductively isolated from them (Federal Register 9/23/94). They are lumped into "late-run" chinook by NMFS and considered as a species under the ESA. As a group these fish are considered to be abundant by NMFS, and do not warrant listing.

Summer Steelhead

In the ISP, the summer steelhead stocks above Priest Rapids Dam are considered as one integration unit. Subbasins include the Wenatchee, Entiat, Methow, Okanogan/Similkameen, Columbia mainstem and minor tributaries between Priest Rapid and Chief Joseph dams. Wild stocks in all of these subbasins are depressed. All subbasins are supplemented from hatchery stock collected at Wells Dam. Naturally reproducing stocks are thought to partially originate from upriver stocks trapped at Rock Island Dam (Mullan et al. 1992). The State

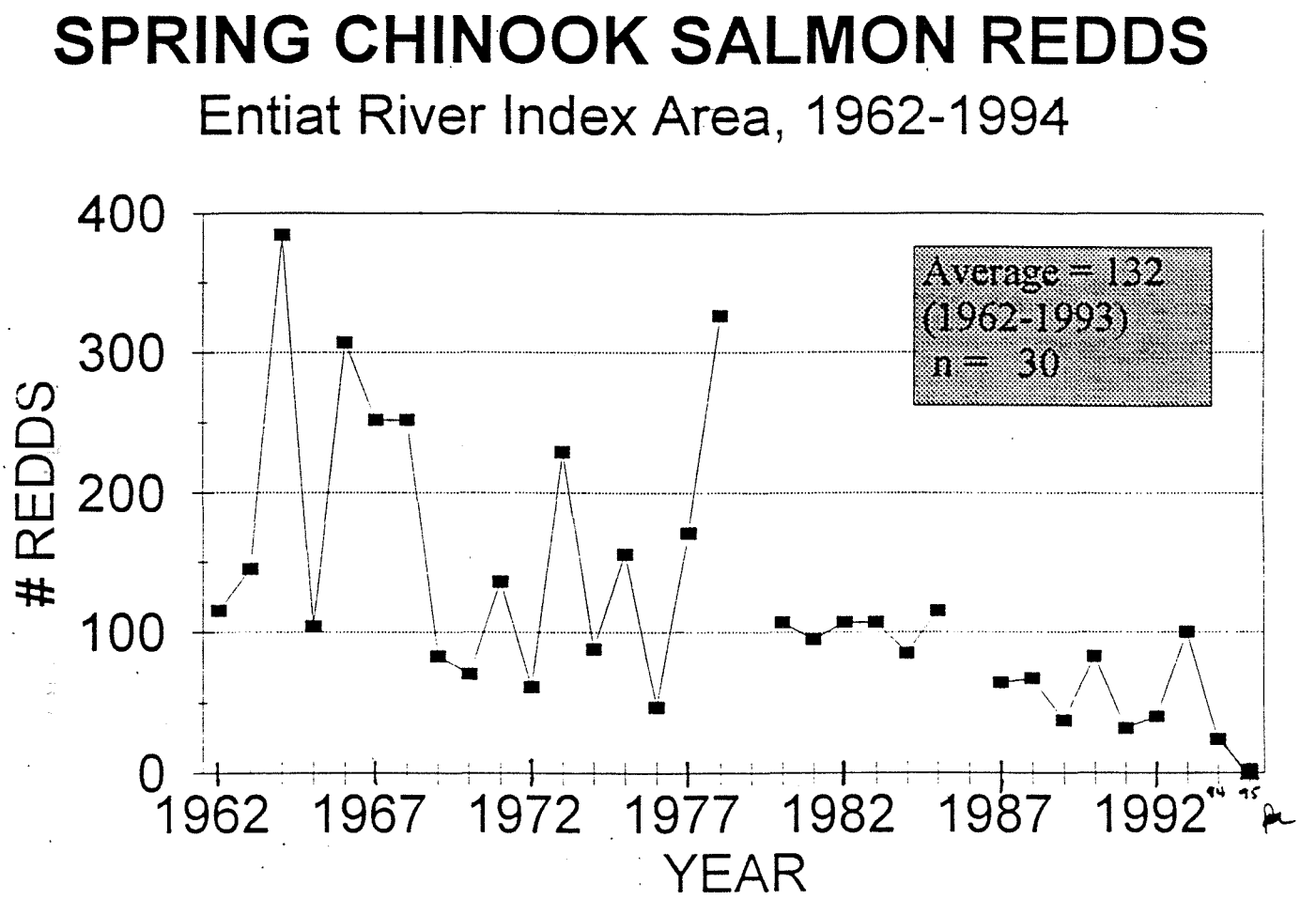


Figure F-9-VI-1 **Spring chinook salmon redd counts.** Data from one day annual surveys in the index area, Fox Creek Campground to Dill Creek (RM 28-21), Entiat River, 1962-1995.

of Washington (WDF et al. 1990) estimated that about 140 natural summer steelhead return annually to the Entiat. The ISP modeled a total subbasin return to the Entiat of 4,250 summer steelhead with a minimum escapement goal of 1,471 fish and a harvest outside the basin of 1,048 if recommended strategies to double the runs were implemented.

SUMMARY

The Wenatchee, Entiat, Methow, and Okanogan subbasins provide the larger scale context for anadromous fish runs in the upper-mid Columbia River Basin or Eastern Washington North Cascades Province. Naturally these subbasins had much harsher environments than the lower subbasins in the Columbia River. The aquatic species evolved for successful dispersal and colonization over long distances (Marcot et al.). All have been impacted by human settlement since the 1860's, to the detriment of the native fish populations (Wissmar et al. 1994). The resulting fish communities have lost their capacity to disperse and colonize over long distances. Wild coho in the upper Columbia are considered extinct, where historically they were widespread (CBFWA 1991).

Changes in the timing and intensity of streamflows may have particularly affected stocks whose life histories were closely linked to historic flow patterns. The systems have generally lost the refuge habitat, which allows for relatively quick recolonization and restoration of the native aquatic species (Marcot et al.). In the Entiat this is illustrated by the lack of instream large wood and side channel in the lower reaches. Another example is the reduction of spawning habitat and filling of pools in the mainstem Entiat with coarse sand from tributary systems such as Brennegan Creek (WDF et al. 1990). In addition, the fish communities have changed, especially in lower mainstem river reaches, because human activities have favored those fishes that are small-medium trophic generalists (e.g., redside shiner) that tolerate warmer water over large fishes that require cooler water temperatures (e.g., coho, bull trout).

References cited in this section are listed after Chapter 5 of this document.

Appendix VII

Climate, Streamflow and Channel Structure

Climate

Climate in the subbasin varies from arid shrub/steppe at the lowest elevations to moist alpine type at the higher elevations. Mean annual precipitation correspondingly ranges from 90 inches to less than 10 inches along the Columbia Breaks due to the rain-shadow effect of the Cascades. Most winter precipitation falls as snow; however, rain is not unusual. Average winter snowfall ranges from 50 inches at the lower elevations to nearly 400 inches on the peaks, where depths may reach 10-20 feet and remain on the ground from mid-November until June.

During summer, thunderstorms frequently develop over the mountains resulting in heavy downpours for brief periods. Occasionally, intense convective storms produce flash floods at the mouths of narrow canyons. Approximately 50 percent of the mean annual precipitation falls between October and January and 75 percent falls between October and March. The total precipitation for the two driest months, July and August, is from 5-10 percent of the annual.

During the summer, mean temperatures in the lower Entiat subbasin usually range between 60 and 70 degrees, decreasing to the 50's at higher elevations. Temperatures in the 90's frequently occur during July and August in the lower valley. In winter, weather systems moving east from the Pacific and outbreaks of cold air from Canada produce frequent changes. During an average winter, temperatures range from 15 to 30 degrees with elevation.

Streamflow

Mean annual runoff varies from less than five inches in the lower valley to 60 inches in the headwaters. Total mean annual runoff for the Entiat at Ardenvoir was 267,800 acre-feet (1.82 cfsm; 25 inches) for the period 1957-1993. The Entiat watershed supplies water for instream, irrigation, wildlife, livestock, industrial and domestic uses.

Selected discharge data for the Entiat at Entiat (419 sq.mi.; Period of Record 1911-1920, 1951-1958) and the Entiat at Ardenvoir (203 sq.mi.; Period of Record 1961-1991) provide a profile of the flow regime:

	--------Streamflow (cfs)--------	
Parameters	**Entiat @ Entiat**	**Entiat @ Ardenvoir**
Range of Mean Annual Flows	275-800	175-621
Range of Annual Peakflows	1,100-11,000	900-6,800
Range of 7-day Mean Low Flows	45-120	36-90

Estimated flow data for the Entiat (at Entiat) indicate that a 44 percent mean annual increase in total water yield occurred from the drainage as a result of the 1970 fire (Entiat Cooperative River Basin Study, 1979).

A graphic summary of the Entiat flow record is provided on the following pages (Precipitation and Streamflow, Peakflows, Seven Day Mean Low Flow, High Flow Months and Low Flow Months).

Channel Structure

Streamflow and stream channel shape are the result of the complex interactions of a variety of factors including: drainage area and shape, vertical relief, climate/precipitation, soils and geology, the age of the basin, geologic processes and human alterations of vegetation, hillslope hydrology, riparian area processes and the drainageway itself. These factors are described in more detail elsewhere in this Appendix and other documents. The following summarizes the most significant of these factors, in order to explain the present relationship of streamflow and channel shape of the Entiat River.

The Entiat/Mad Subbasin is young in age, small in area (416 square miles), and short in length (42 miles) relative to the Columbia River drainage as a whole and to neighboring subbasins to the south (Wenatchee River) and north (Methow River; see Figure 2.1 in Chapter 2). The steep topography, pinnate drainage structure, relatively low drainage density (1.6 miles per square mile), and short drainage length promote a rapid mainstem flow response time to runoff ("flashy" flow regime) and a wide range between peak flows (3,500 cfs mean annual) and low flows (80 cfs mean annual).

Although major (infrequent) flood events can significantly alter both the stream channel and associated floodplain, it is the bankfull discharge that is primarily responsible for the maintenance of channel geometry (width and depth). "Bankfull discharge" (1.5-year return period event) is roughly equivalent to the mean annual peakflow.

The width to depth ratio of the lower 25 miles of the Entiat River is high (greater than 25). This condition is due to two factors: natural channel forming processes based on the "work" performed by bankfull discharge and the degree of artificial channelization. Above the Potato Creek moraine, channel shape is primarily dictated by bankfull discharge and valley morphology. Below the Potato Creek moraine, between Ardenvoir and the mouth, channelization has created an artificially high width to depth ratio to carry flood flows (greater than bankfull discharge) "safely" out of the subbasin (refer to Figure 2.1 in Chapter 2).

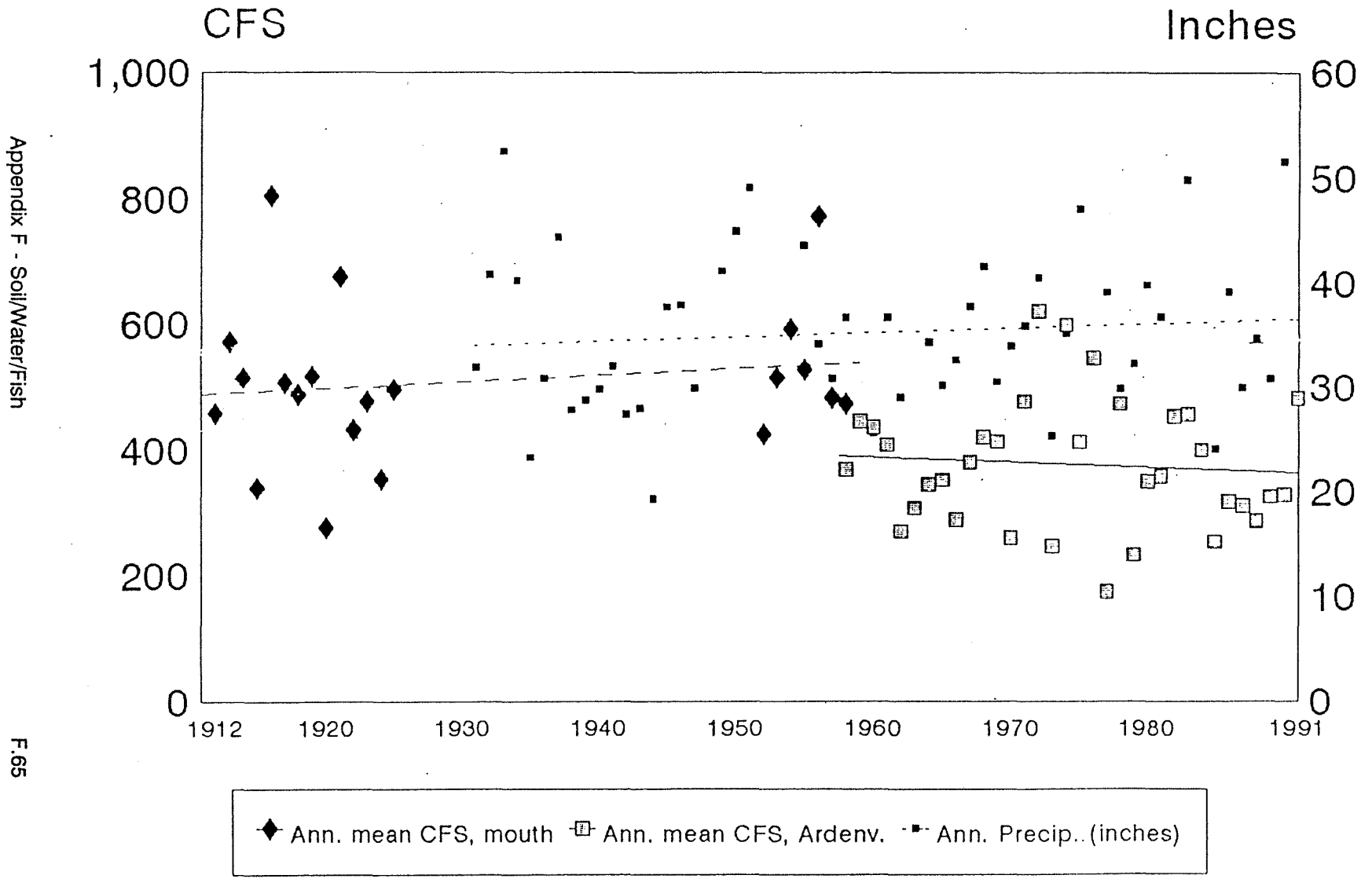
This has several consequences for anadromous fishes. Chinook and sockeye salmon enter the lower Entiat under favorable flow conditions (depth and velocity), when flows are declining from the June peak. They spawn in the reach above the moraine from late August to mid-October under favorable low flow conditions. In unusually low flow years, spawning salmon find a shortage of deep resting pools and much of the suitable spawning gravel dewatered. The eggs incubate for about 90 days, depending on water temperature. Because of the high width to depth ratio, water over the spawning gravels is shallow (less than one foot deep) and cools more quickly, resulting in extended incubation periods, direct mortality, and the formation of anchor ice which can damage eggs and fry. Under favorable conditions, fry emerge from the gravels in December prior to winter extremes. In the extreme low flow years, emergence is delayed until January or February when conditions in the river are harshest (i.e., low temperatures, low flows, low food supply, anchor ice).

Juvenile rearing begins in early spring during a period when the River provides increasingly favorable conditions of flow, temperature and food supply. Above the Potato Creek moraine, rearing conditions are good to excellent, with adequate cover, favorable velocities and high flow refuge habitat. Below the moraine, cover is lacking and channelization has increased velocities and eliminated high flow refuge habitat.

At its extremes, instream flow is a primary limiting component to fish habitat in the Entiat subbasin. A determination of a minimum instream flow is a necessary step in management of aquatic resources in this subbasin. The recently completed minimum instream flow analysis utilized the best available methodology (IFIM) and information. Any interim or final minimum instream flow recommendations need to account for the unique characteristics and management history of the subbasin. Opportunities to restore important channel characteristics in the lower river have been identified through the Coordinated Resource Management Planning process. These include structural and vegetative treatments designed to reduce the width to depth ratio resulting in more diverse habitat (e.g., pools, cover, rearing habitat). We believe these projects would beneficially alter the channel structure, influencing the outcome of future instream flow analyses.

PRECIPITATION AND STREAMFLOW

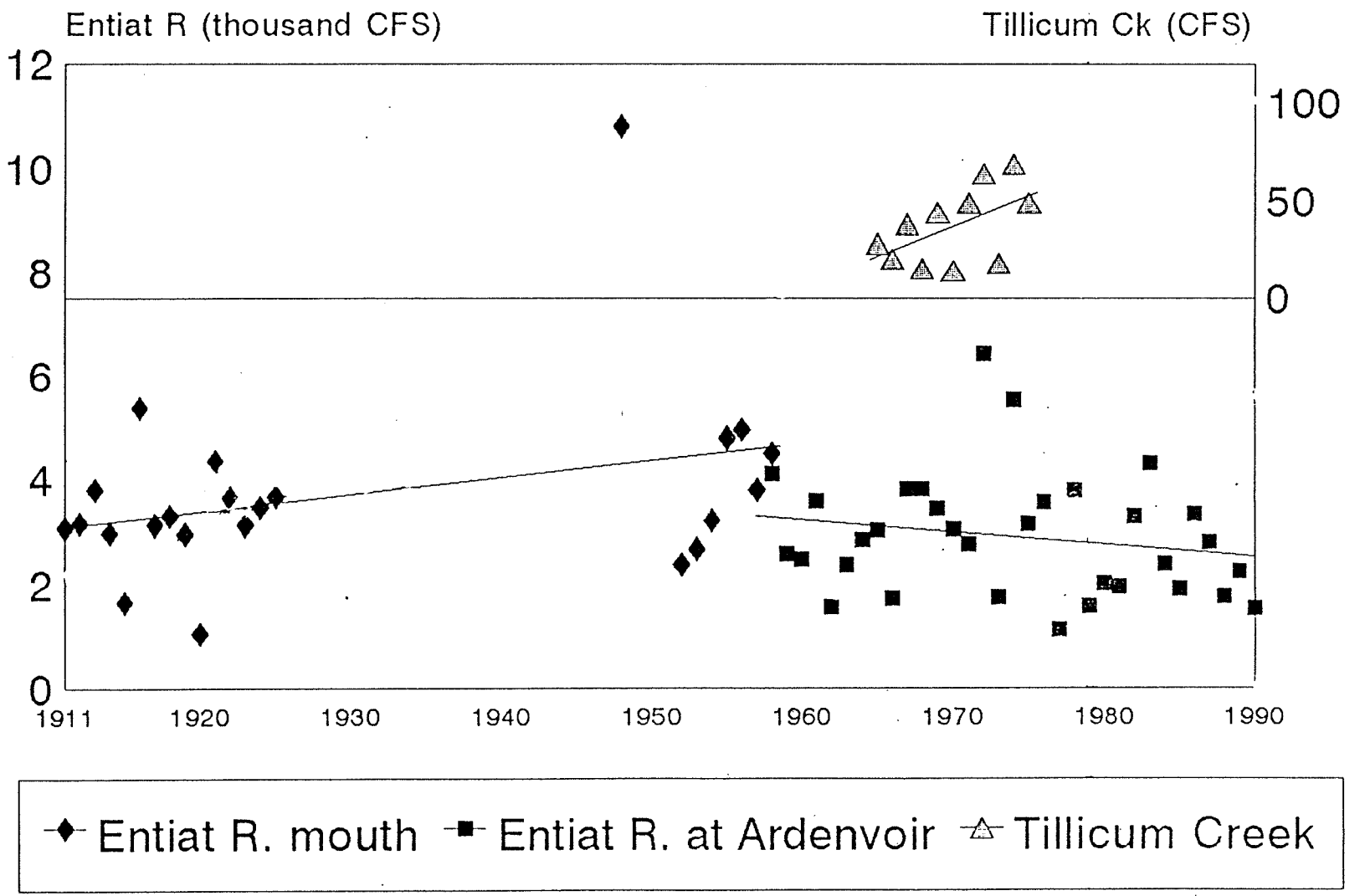
1912 - 1991



Annual mean discharge, 2 USGS Gaging Stations on Entiat River; Precipitation (inches) from Stehekin.

PEAK FLOWS

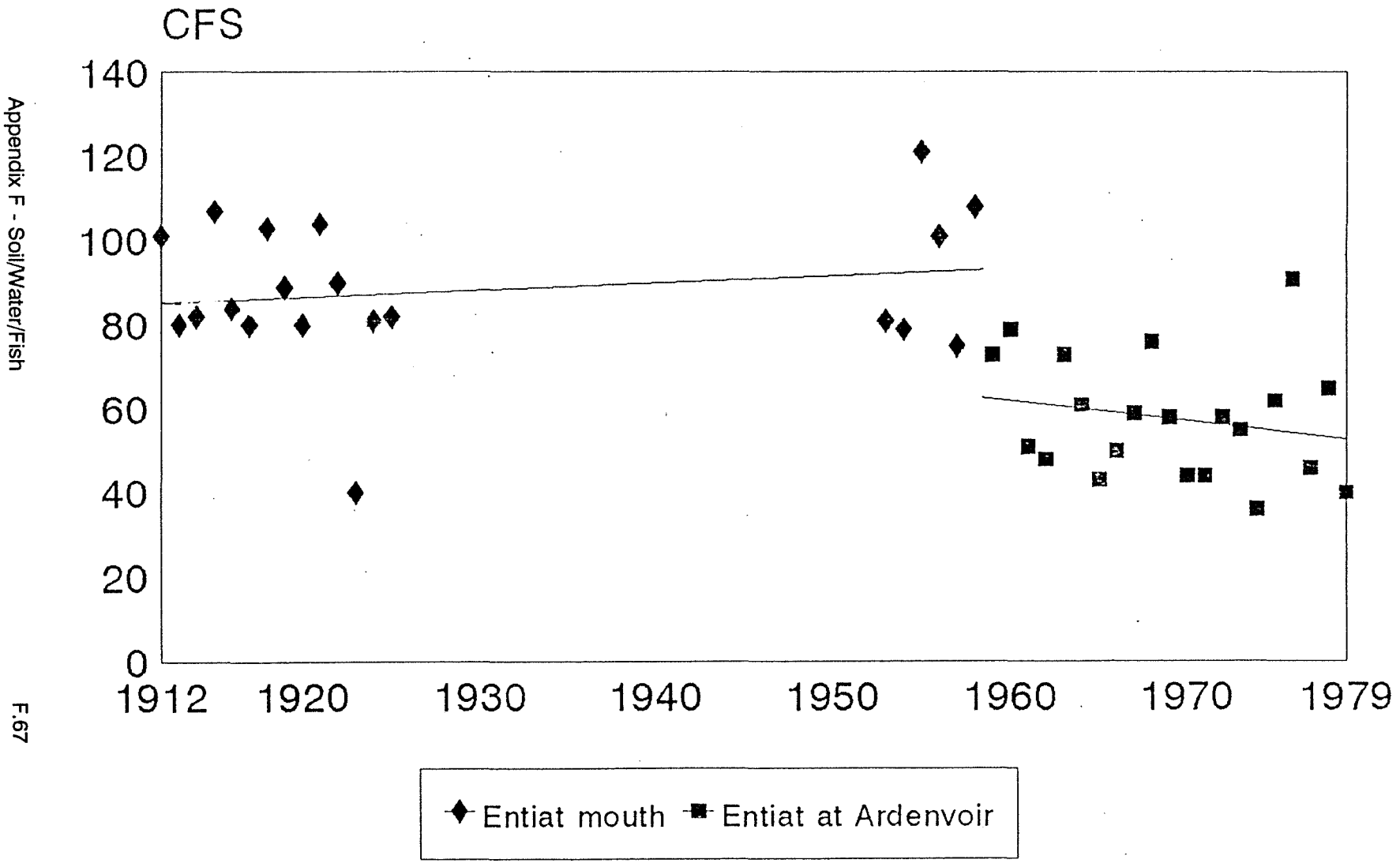
1911-1991



USGS data from Entiat River mouth, Entiat River at Ardenvoir, and Tillicum Creek

SEVEN DAY MEAN LOW FLOW

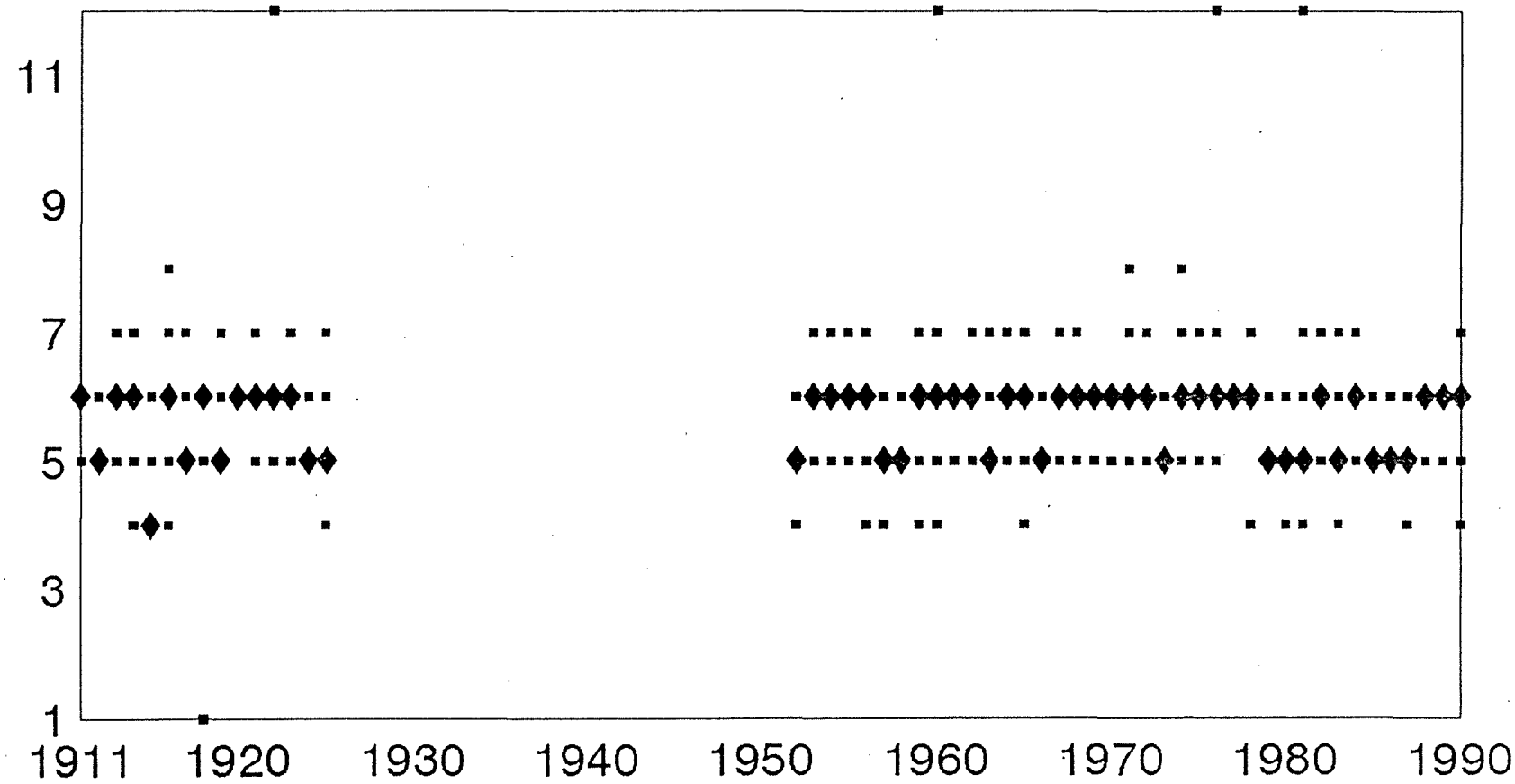
1912-1979



USGS gaging station data from the Entiat mouth and the Entiat at Ardenvoir

HIGH FLOW MONTHS

1911-1990



Diamond indicates month with highest daily flow.

USGS gaging station data from Entiat River mouth (1911-1958) and Entiat R. at Ardenvoir (1958-1990)
For Entiat mouth, "high flow months" are months in which a daily flow >= 1000 cfs occurred.
For Entiat at Ardenvoir, "high flow months" are months in which a daily flow >= 800 cfs occurred.

LOW FLOW MONTHS

1911-1991

Diamond indicates month with lowest daily flow.

USGS gaging station data from Entiat River mouth (1911-1958) and Entiat R. at Ardenvoir (1959-1991)
Entiat mouth "low flow months" are months in which a daily flow <=120 cfs occurred.
For Entiat at Ardenvoir "low flow months" are months in which a daily flow <= 100 cfs occurred.

APPENDIX VIII

DOE Water Quality Data Summary - Entiat River

The following document by William Ehinger (Washington State Department of Ecology) provides a review of existing water quality data for the DOE ambient monitoring station on the Entiat River.

A Review of the Data from the Entiat River Basin Collected for the Ambient Monitoring Database

by
William Ehinger

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Ambient Monitoring Section
Olympia, Washington 98504-7710

Water Body No. WA-46-1010

INTRODUCTION

Only one ambient monitoring sampling station is currently maintained in the Entiat River basin and it is located approximately 1.5 miles upstream from the mouth at a private bridge. Sampling was conducted during wateryears (WY) 1959-66, 1972, 1975-76, 1978-91, and is now included in the WY 1994 sampling schedule. This report is limited to the period WY 1978-91, because prior collections were more limited in the number of parameters recorded, and the detection limits of several chemical constituents have changed substantially making comparisons difficult. What follows is divided into two sections: 1) an analysis of trends (over time) of each parameter using a seasonal Kendall test for trends and a discussion of the results; and 2) a brief narrative description and graphical display of each parameter to illustrate the median and variability of the data by month.

Trend Analysis

The seasonal Kendall test for trend is a nonparametric test for detecting changes over time. Because it is a nonparametric test, it is not affected by non-normally distributed data, heteroscedasticity, or a moderate percentage of "below detection limit" data (unless the detection limit has changed). Initially, this analysis was done on all parameters (Table 1) using the original data. If a statistically significant trend was detected or a pattern was seen in the data which may have affected the result, then the data were flow-corrected or time-corrected and the trend analysis was repeated on the corrected data. Data correction is simply accounting for correlations between two variables (*i.e.*, suspended solids and flow, water temperature and the time of day when temperature was measured) using regression analysis. Effects were considered to be statistically significant if $P < 0.1$.

Table 1. Results of seasonal Kendall tests on Entiat River data, WY 1978-91. i = increasing trend, d = decreasing trend, n.s. = non significant result. $P<0.05$ was considered significant.

Parameter	Uncorrected	Flow-corrected	Time-corrected*
Temperature	i		n.s.
Dissolved Oxygen	d		n.s.
O_2 saturation	n.s.		
pH	**		
Specific conductivity	n.s.	d	
Total suspended solids	n.s.	d	
Turbidity	***		
Nitrate+nitrite-N	d	d	
Ammonia-N	***		
Total phosphorus	***		
Soluble reactive phosphorus	***		
Fecal coliform bacteria	d	****	

* corrected for correlation with the time of day when the sample was collected
** no analysis was done because of probable changes in measurement technique
*** no analysis was done because many values were at or below detection limits and the detection limits had decreased during the period of record
**** there was no significant correlation with flow

Results

A significant increasing trend in temperature was seen in the raw data, but this was apparently due to a change in the time of day when the data were collected. Prior to 1984, sampling usually occurred between 6:00 and 10:00 a.m., but beginning in 1984 sampling usually occurred between 12:00 and 4:00 p.m. This probably accounts for the apparent upward trend seen in the raw data because no trend was seen in the time of collection-corrected temperature data. Similarly, a decreasing trend in dissolved oxygen concentration (D.O.) was detected in the raw data. However, because D.O. is inversely related to water temperature and the fact that no trend was detected in percent oxygen saturation, the decreasing trend in the raw D.O. data should be considered to be an artifact of the change in the time of data collection. A marginally significant decreasing trend was seen in specific conductivity in the raw data, and a significant decreasing trend was detected in the flow transformed data. Total suspended solids showed a non-significant decreasing trend in the raw data but a significant decreasing trend in the flow-corrected data. A

decreasing trend in nitrate+nitrite-N concentration was seen in both the raw data and the flow-corrected data. No significant trend was detected in flow. Fecal coliform bacteria showed a significant decreasing trend in the raw data. No flow-correction was applied to the data because the relationship was very poor ($r^2 < 0.1$). An obvious change in pH was seen after 1984, which was probably due to the measurement technique. No analysis was done on these data. Many of the values for turbidity, ammonia, total phosphorus and soluble reactive phosphorus were below the detection limit and the detection limit changed during the period of record. Because of this, no trend analysis was done.

Discussion

No significant trends were seen in flow, temperature, or dissolved oxygen concentration in this analysis. Apparent trends in temperature and dissolved oxygen concentration were artifacts of the change in the time of sampling from morning to the afternoon in WY 1984. Significant decreasing trends were detected in specific conductivity, total suspended solids and nitrate+nitrite-N concentration. These could all be related to a decrease in runoff related inputs to the stream. If we had information about the type and extent of forest management and agricultural activities in the basin, then we may be able to speculate as to the causes of these trends. A decreasing trend was also seen in fecal coliform data. Ammonia, total phosphorus, and soluble reactive phosphorus concentrations were usually quite low. Trend analysis was not recommended on the variables because of the large proportion of 'below detection limit' values and the changes (decreases) in detection limits during the period of study. The turbidity data exhibited the same problems and was also excluded from analysis.

Description

See Figures 1-11 for descriptive box plots of all variables. Flow usually peaked in June (Figure 1), as did suspended sediment concentration (Figure 2). Both specific conductivity (Figure 5) and nitrate/nitrite-N concentration (Figure 7) were negatively correlated with flow, probably due to dilution during snowmelt, with lowest median values occurring in June. Temperature regularly exceeded the Class A standard (18°C) in August and September (Figure 3). As mentioned above this was related to the time of day when the sample was collected and probably reflects a chronic condition in late afternoon. Dissolved oxygen did not fall below the 8 mg L-1 standard (Figure 4). pH was varied little seasonally but did occasionally exceed the 8.5 standard (Figure 6). Ammonia-N, total phosphorus, and soluble reactive phosphorus concentrations were usually near or below the analytical limits of detection (Figures 8-10). Fecal coliform counts displayed little seasonal variation or correlation with flow and were generally < 10 per 100 mL, although occasional high counts were recorded.

Temp Stds

Class A $16.0^{\circ}C \times \frac{9}{5} = 28.8 + 32 = 60.8^{\circ}F$

Class A $16^{\circ}C \times \frac{9}{5} + 32 = 64.4^{\circ}F$

Conclusions

High temperatures in the afternoon during late-summer and fall is the major water quality standard violation seen in these data. Suspended solids concentrations were generally low, but this may be deceptive because large quantities of sediment may be transported during infrequent high flows and are often missed by monthly sampling. The pH excursions above 8.5 were relatively infrequent. In general, nutrient concentrations were low (ammonia-N, total phosphorus and soluble reactive phosphorus) while nitrate/nitrite-N concentration was well within the range expected of natural conditions and was decreasing. Fecal coliform counts were usually low.

FIGURES

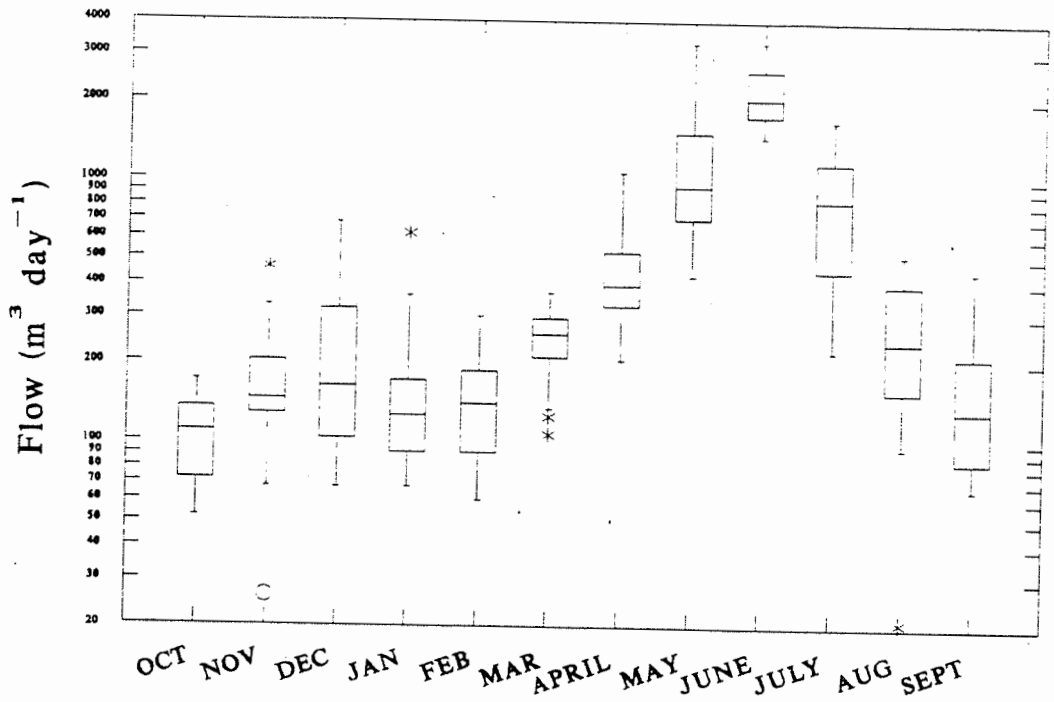


Figure 1. Flow distribution by month in the Entiat River. WY78–91.

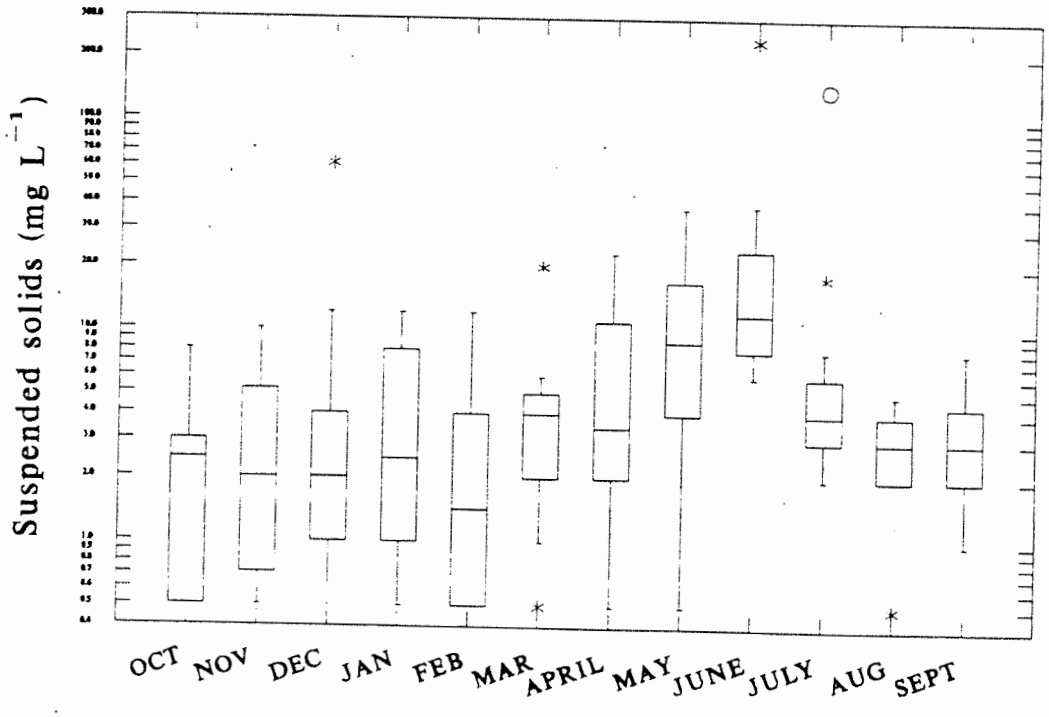


Figure 2. Suspended solids concentration distribution by month in the Entiat River. WY78–91.

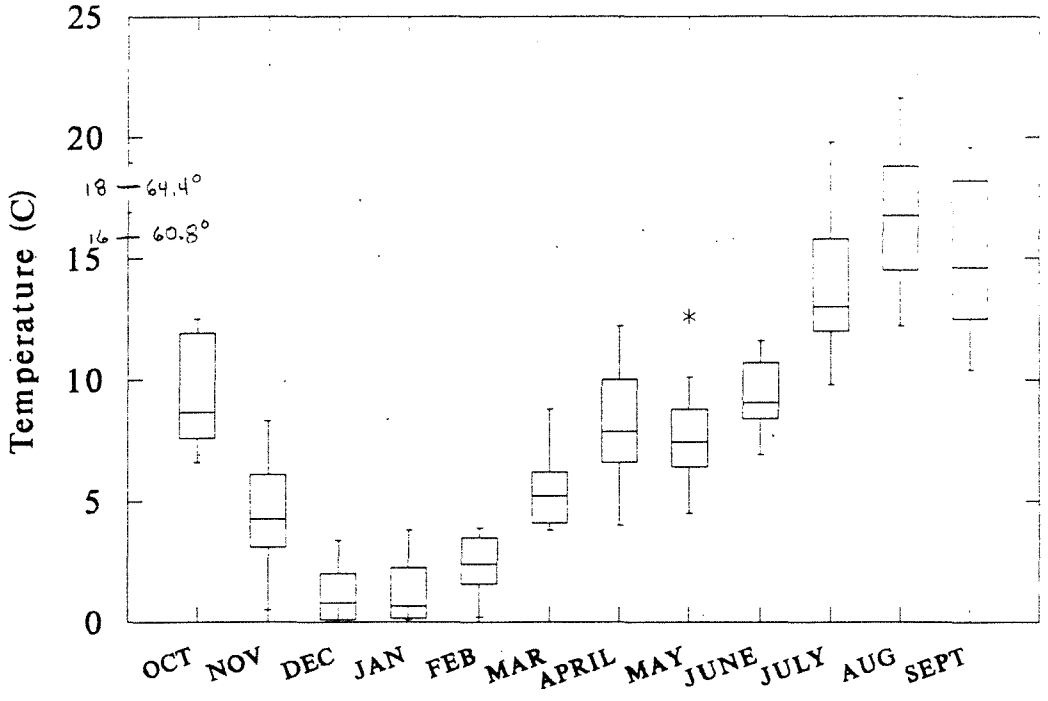


Figure 3. Temperature by month in the Entiat River. WY78-91.

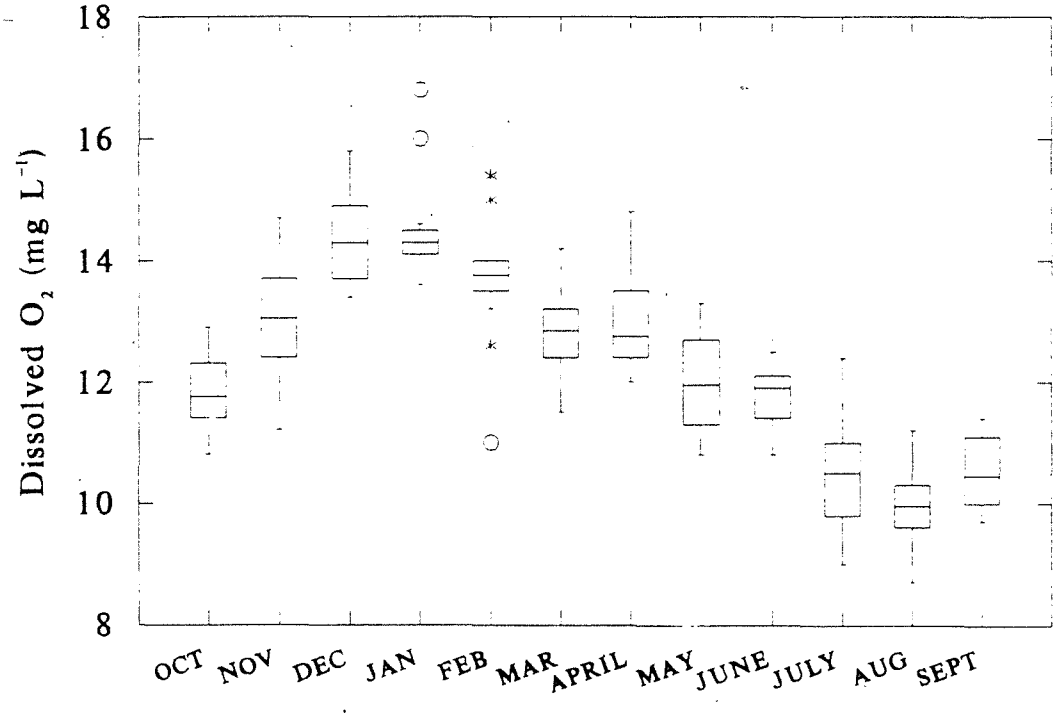


Figure 4. Dissolved oxygen concentration by month in the Entiat River. WY78-91.

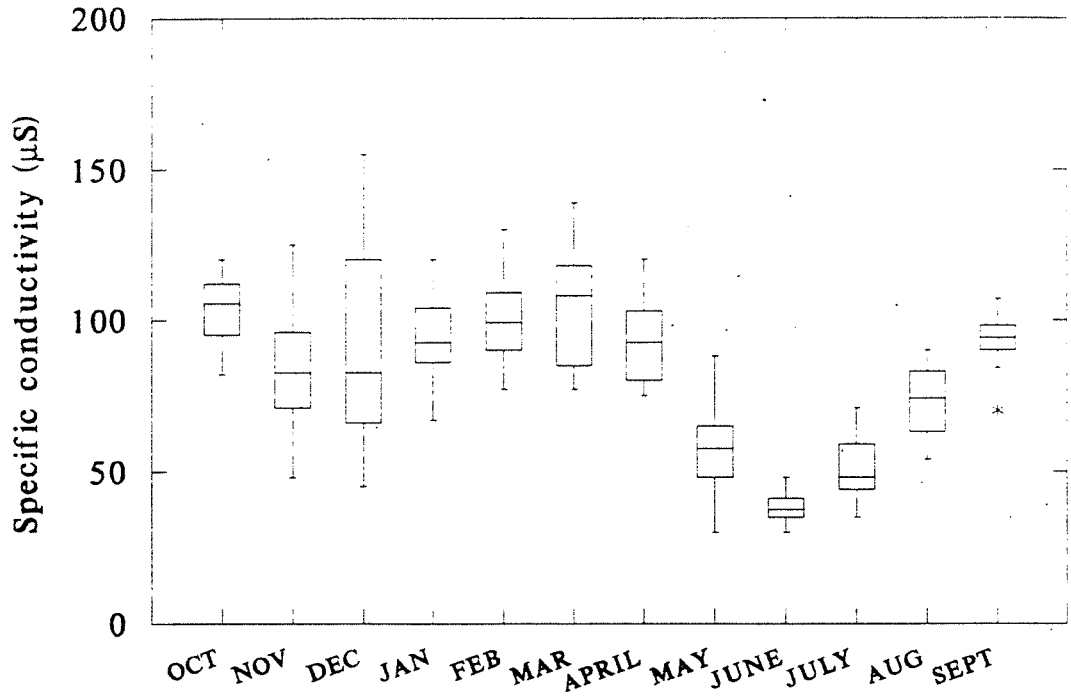


Figure 5. Distribution of specific conductivity values by month in the Entiat River. WY78-91.

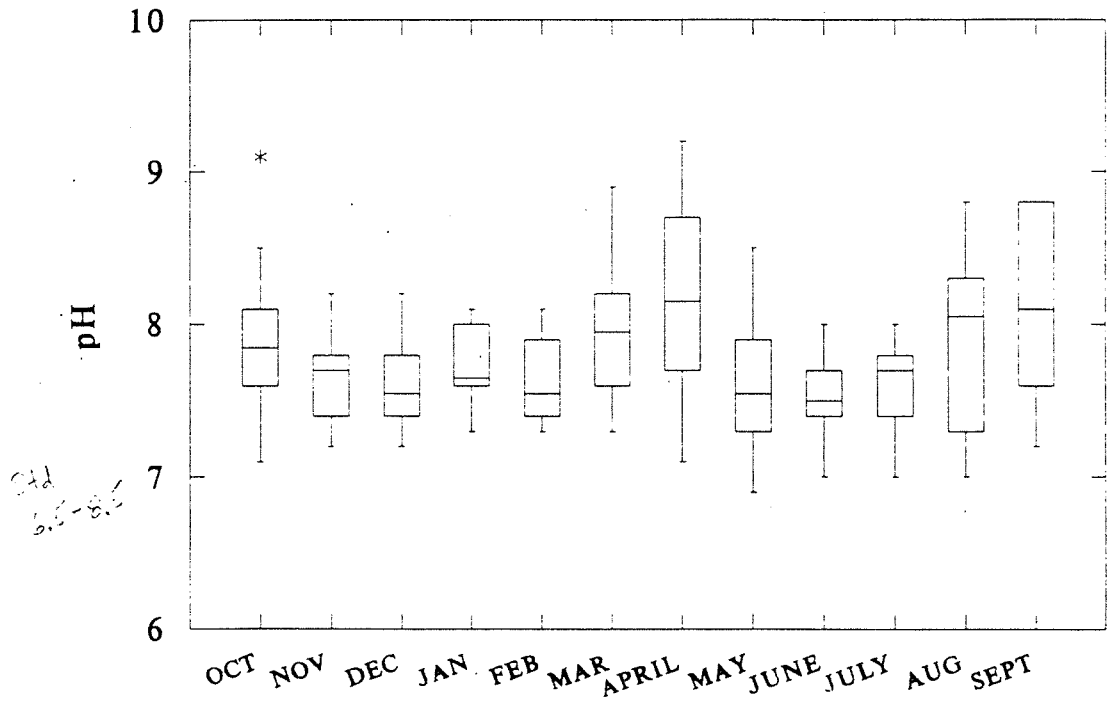


Figure 6. Distribution of pH values by month in the Entiat River. WY78-91.

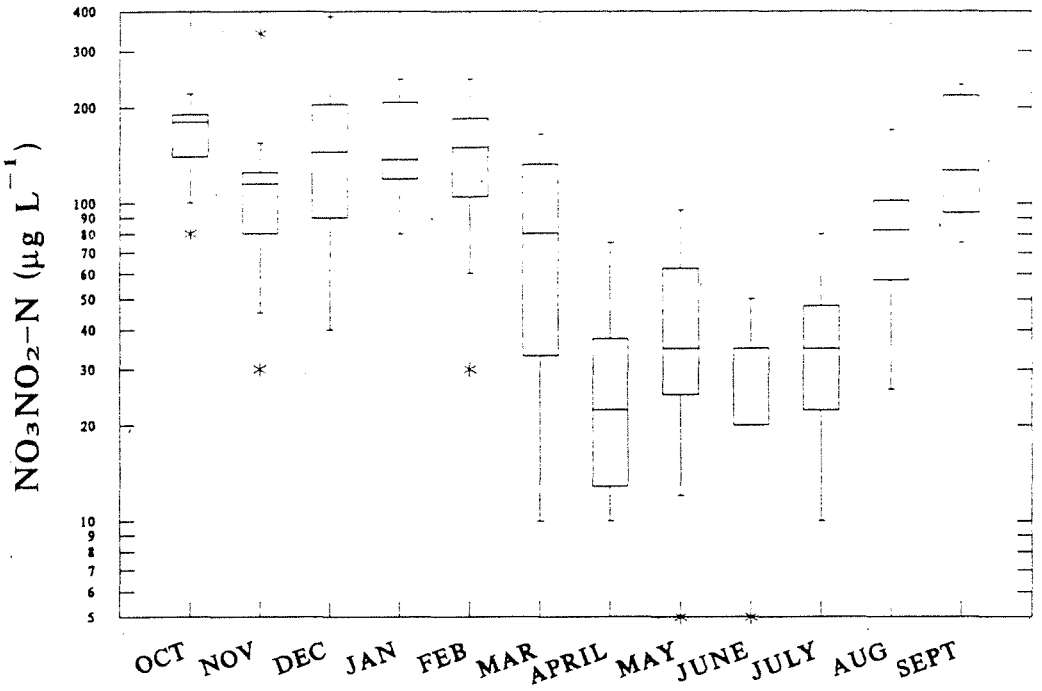


Figure 7. Nitrate+nitrite-N concentration distribution by month in the Entiat River. WY78-91.

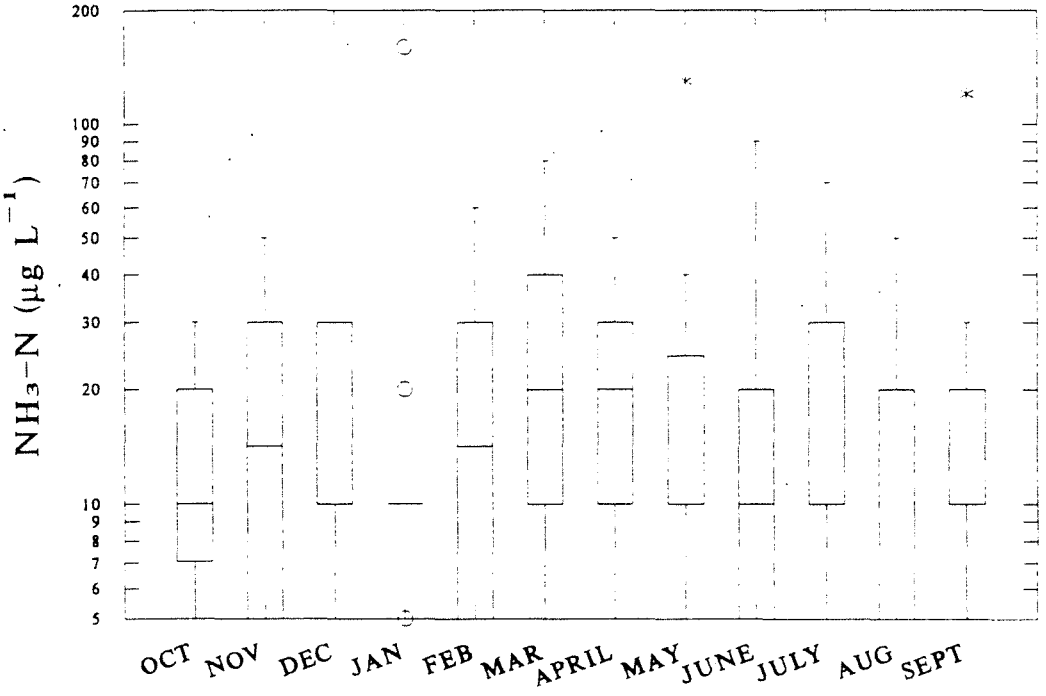


Figure 8. Ammonia-N concentration by month in the Entiat River. WY78-91.

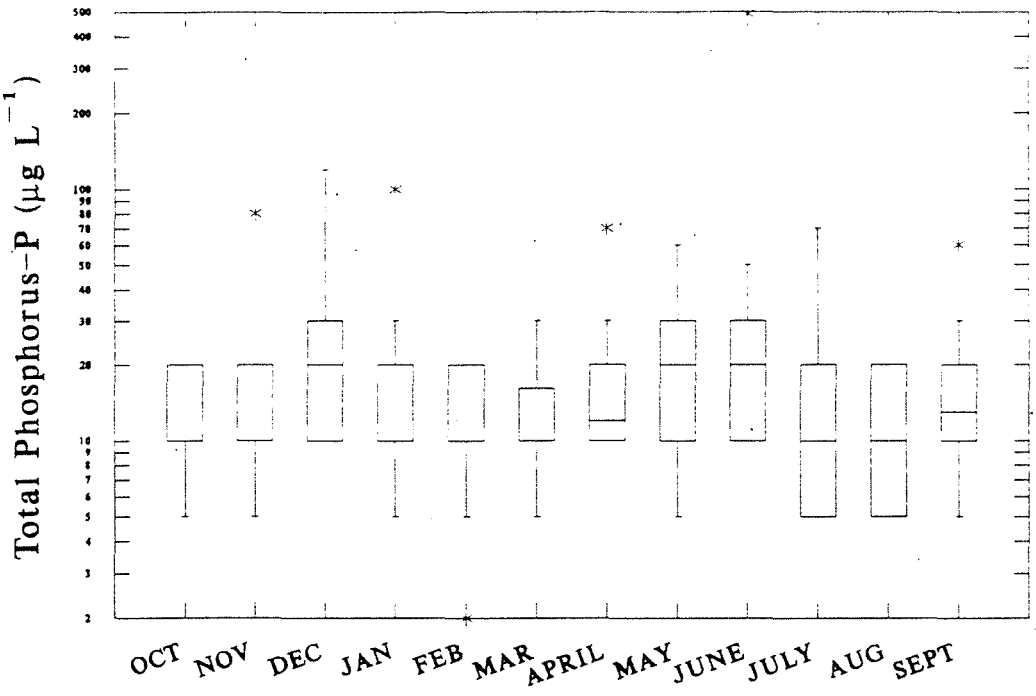


Figure 9. Total phosphorus concentration by month in the Entiat River, WY78-91.

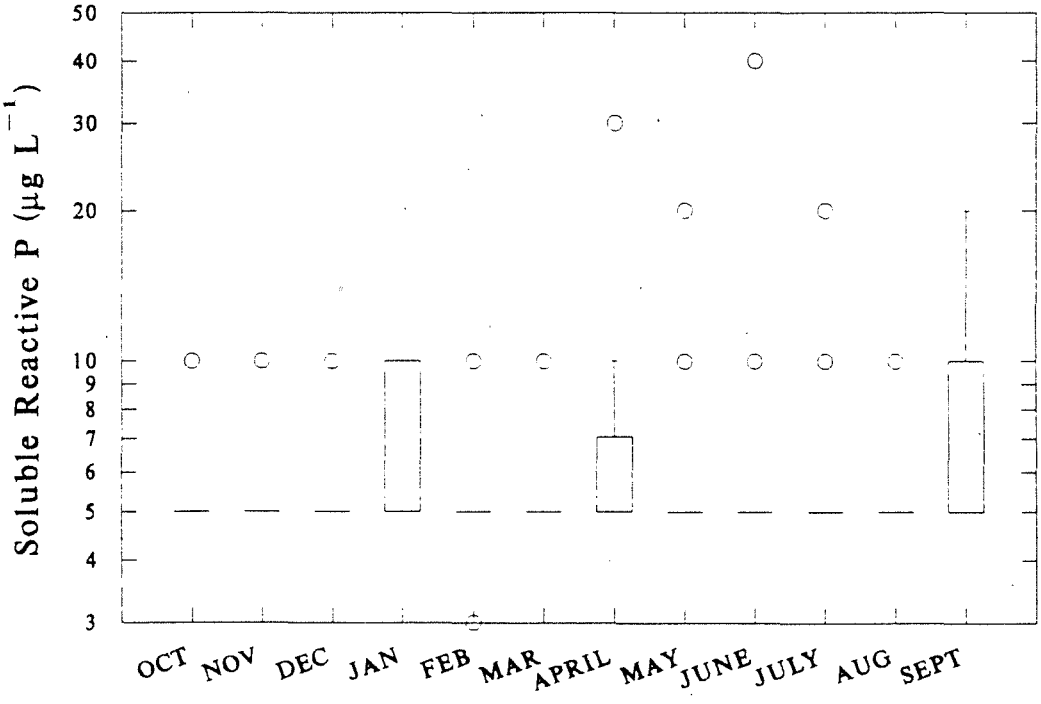


Figure 10. Soluble reactive phosphorus concentration distribution by month in the Entiat River, WY78-91.

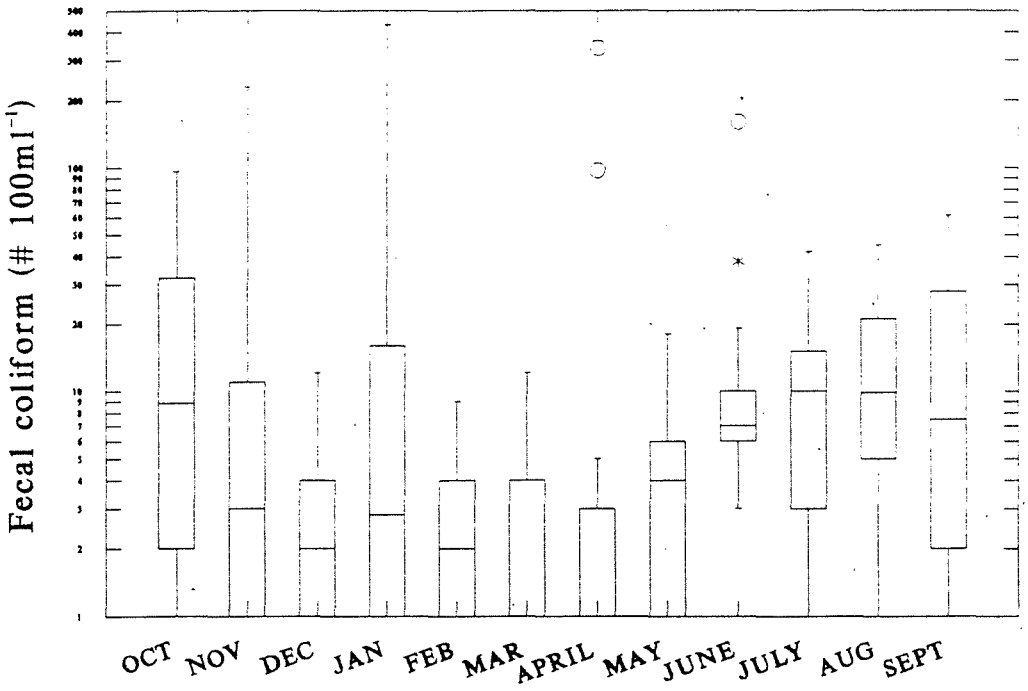


Figure 11. Fecal coliform values by month in the Entiat River. WY78–91.

Appendix G
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Range Uses

Page

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Appendix G-1

Area Grazing History

"Grass that waved in the breeze like a wheat field;
No sagebrush and very little buckbrush (bitterbrush);
No sunflowers (balsamroot), only on the banks of the
Columbia River."

Introduction

This description of the range on the Entiat District, from the Columbia to Mud Creek in 1894, was given by Ed Hedding and other old timers of the area.

Grazing in the lower Entiat Valley began around 1894, in the vicinity of Entiat. By 1894 Rogers, Howe and Case, operating a large mercantile store in Waterville, had many of the Entiat residents in their debt for merchandise. Since money was scarce, they accepted land and cattle as payment. In 1894, they constructed the big irrigation ditch that served the area, where Entiat now exists and the flat to the north, until a 1972 flood caused the Irrigation District to abandon the ditch. The mercantile owners planted 300 acres of that land to alfalfa. Their cattle, which had increased to 300 head by 1900, were turned out in the spring as soon as the snow started going and were left until bad weather drove them back in the fall. Cattle from the Big Bend country were shipped in as feeders to clean up the surplus hay. The company sold out after 1900, and their lands were gradually converted to orchards.

Every rancher in the area had cattle and horses. At one time, it was estimated that 1,000 head of cattle and 400 head of horses grazed the area from Entiat to Quartz or Stormy Creek as it is now known. The horses were out year round. In addition to the cattle and horses, about 150 hogs grazed almost year round and were known to uproot large areas of grazing land. Cattle numbers started dwindling about 1909 and continued a slow decline until 1947. Until the 1994 Tyee Fire burned through most of the Potato Creek Allotment and part of the Mosquito Ridge Allotment, the permitted number of cattle had not changed drastically.

Prior to the establishment of the Chelan National Forest, there was considerable competition between sheep bands for the desirable high country range. Grazing began in the 1890's. They began in the spring, at the Columbia River, around May when the low country greened up, and pretty much followed the receding snow to the high country. As many as 13,000 sheep were herded from the Columbia River to the head of the Entiat. The Plummer Report of 1902 states that upwards of 60,000 sheep were located in the upper Entiat and Mad River. At any rate, there were a lot of sheep grazing the Entiat, and there was a lot of abuse prior to the Forest Service beginning to manage the range. This added to the overuse of the low country by all classes of stock.

This historic grazing, mostly unmanaged, likely resulted in altered vegetation patterns, changes in wildlife habitat, increased sedimentation, stressed riparian stream channels and compacted soils. This early grazing pressure preceded the advancement of noxious weeds, but provided a window for noxious weed infestation due to altered plant communities. Range condition deteriorated steadily in the early 1900's due to unregulated grazing pressure. Evidence of this still exists today on Graham and Pyramid Mountains in the form of terracing on the hillsides. The rate of this decline was likely reduced with the inception of grazing regulations and the conversion of lands into orchards.

The Entiat River drainage was transferred to the Wenatchee National Forest from the Chelan National Forest by Executive Order, on December 31, 1920. The Chelan National Forest was established, by act of Congress, in 1908. However, T26N, R20E was first withdrawn for Forest purposes November 14, 1906, with the proclamation coming one year later on November 2, 1907. Later on November 2, 1916, this land and the south half of T27N, R20E were eliminated as Forest land, except for two administrative sites.

The Potato Creek Allotment was created in 1926, when George Brown was approved for 65 head of cattle and six horses. However, Mr. Brown had been permitted by the Chelan Forest, prior to 1912. In addition, he had been grazing those lands that had been eliminated as Forest land. The Brennegan brothers were also early users of this area; they ran horses and cattle. Old letters in the Forest Supervisor's Office show that they were in trespass many times.

The original Allotment included Potato Creek and Stormy Creek. The Mud Creek, Crum Canyon and Moe Creek units were added as the range became available. About 1928, the Forest Service began to acquire lands in T25N, T26N and the south half of T27N, R20E. Soon after this acquisition program began, grazing lands were placed under permit.

In 1966, with range analysis results compiled from 1960 and 1961 studies, a management plan was implemented. Grazing is a legitimate and accepted use of the National Forest under the Multiple-Use concept. In 1976, the entire Potato Creek Allotment went to a Rest Rotation Management system.

Currently, there are two permittees on the Potato Creek Allotment--Cannons and Kiles. Prior to the 1994 fires, their permitted numbers were: Cannons-48 cow/calf, April 1 to September 30; Kiles-50 cow/calf, 2 bulls and 4 cow/calf on/off, May 1 to September 30.

In 1990, the Wenatchee National Forest Land and Resource Management Plan was approved and implemented. Standards for grazing utilization are more strict than those previously used under the prior Multiple-Use plan.

Also in 1990, key use areas were defined and the District informed the permittees that the new utilization standards would go into effect beginning with the 1991 grazing season. In 1991, implementation of the Forest Plan standards and guides on range utilization began, and in 1992, the intent of the Forest Plan was being fully implemented.

In the spring of 1992, the Forest sponsored a utilization workshop in conjunction with the Soil Conservation Service for Forest Service employees and permittees. The Emphasis was to provide education on how and why utilization was established in the Forest Plan and how it should be measured.

Overutilization of the riparian areas in the Mud and Potato Creek pastures in 1992 resulted in the closure of those pastures to grazing in 1993. When riding and herding by the permittee failed to keep the cattle out of the Mud Creek pasture, fence and cattleguard locations were changed.

In 1994, the Potato Creek Allotment was grazed for approximately two months until the Tyee Fire forced them off the Allotment July 27th. The Potato Creek Allotment has been closed to grazing since the Fire. The Allotment will remain in a non-use status until the established criteria for re-entry of livestock have been met (refer to Appendix G-4).

An analysis was started in 1995 to establish a temporary pasture (not to exceed five years) in the Mills Canyon/Roaring Creek area to provide grazing for some of the displaced, permitted cattle.

The Mosquito Ridge Allotment was established in 1983 for sheep and cattle. The permittee at present is Martinez, who is permitted 1,000 ewe/lamb, May 15 to August 30. The entire Allotment area burned in 1970.

The Allotment area has a history of livestock grazing prior to the 1970 fires. Sheep grazing began in earnest in the early 1890's. In 1922, the Gold Ridge Sheep Allotment included the Mosquito Ridge Allotment area and stretched from Chumstick Mountain to the north end of Miners Ridge and from the summit of the Entiat Mountains to Mad River. Hans Harder and Son were permitted 1,000 ewe/lamb units from June 1 to July 1 and 1,400 dry sheep from July 2 to September 15.

About 1928 or soon after, the Moe Creek unit was added to the Potato Creek C&H Allotment. From 1961 to 1970, Randy Cannon used Moe Ridge as a fall range for his cattle. The years immediately following the 1970 fires saw little grazing in the area. The rehabilitation work, which included grass seeding, created a productive transitory range. From 1976 to 1981, the area was grazed by both cattle and sheep.

In 1981, season-long use by sheep began. After the Mosquito Ridge Allotment was created, the season was set from May 15 to August 31, for 1,000 ewe/lamb units. Since the Allotment was established in 1983, it has been grazed almost entirely by sheep.

The area of the Mosquito Ridge Allotment includes from lower Moe Ridge to the Entiat Mountain summit and from Roaring Ridge to Tillicum Creek and the lower four to five miles of Gold Ridge.

Appendix G-2

Existing and Desired Rangeland Conditions
Entiat Analysis Area

Existing Condition of the Potato Creek Cattle Allotment

Three vegetation types grow on the Allotment; timber, meadow, and grassland with the timber and meadow types predominating. The grasses include a mixture of increasers, decreasers, and invaders. Increasers are plant species native to a site which increase in relative amount, at least for a time, under heavy use. Decreasers are those grasses native to a site which decrease in relative amount, at least for a time, under heavy use. Invaders are those grasses that are absent or only minimally present in the original vegetation and which invade or rapidly increase as a result of disturbance or continued heavy grazing. Those grass species found within the Allotment and classified as increasers are as follows: Sandberg bluegrass (*Poa Secunda*), Meadow sedges (*Carex* Spp.), Pinegrass (*Calamagrostis rubescens*), and Junegrass (*Koleria cristata*). Those grass species found within the Allotment and classified as decreasers are: Elk sedge (*Carex geyeri*), Bluebunch wheatgrass (*Agropyron spicatum*), Beardless Bluebunch wheatgrass (*Agropyron inerme*), mountain brome (*Bromus carinatus*), and Idaho fescue (*Festuca idahoensis*). Those grass species found within the Allotment and classified as invaders are: Kentucky bluegrass (*Poa pratensis*), Redtop (*Agrostis alba*), and Timothy (*Phleum pratense*). The most common grass species found in the Allotment are elk sedge, Bluebunch wheatgrass, and Sandberg bluegrass.

Of the 44,640 acres in the Potato Creek Allotment, only 13,904 acres are considered suitable for grazing. This includes 5,902 acres of primary range and 8,002 acres of secondary range. Simple primary range criteria include slopes of 0-30 percent, water within ½ mile, and vegetation being mostly grassland and/or open ponderosa pine. Secondary range criteria are slopes of 0-50 percent, water greater than ½ mile away, and vegetation being more of a closed forest type with fewer openings. Most of the range is considered unsuitable for grazing due to the soils and watershed values (mainly steep slopes and erosive soils).

The range condition on the Allotment varies from excellent to very poor. According to the Forest Service Range Analysis and Management Handbook, the term "range condition" was coined to describe various successional stages of vegetation caused by grazing. The stages are rated according to the percent of decreasers, increasers, and invaders found within a given area. Excellent describes the natural community, good is 50-75 percent decreasers, fair is 25-50 percent decreasers, poor is 0-25 percent decreasers, and very poor is any value below that. Thus, good condition means that some past livestock overgrazing occurred and there is some potential for improved production and species composition. Poor condition means there was severe past overgrazing and there is great potential for improved production and species composition.

The overall condition of the Allotment is fair to good. The riparian areas were found to be in mostly poor or very poor conditions with use ranges varying from 35 percent to 75 percent. These areas, in general, do not meet utilization standards and in some areas far exceed them. The mid-level shrub component is disappearing and tree regeneration is lacking (especially aspen). This is mainly due to the concentration of cattle, overgrazing, and poor distribution. The uplands were found to be in mostly fair and good condition, with some areas in poor condition. Forest Plan Standards are being met in these areas, but this is occurring at the expense of the riparian condition. The riparian areas and valley bottoms are providing 80 percent of the livestock forage. Landowner conflicts are frequent occurrences because livestock spend a majority of time in the valley bottoms where residents live.

Before the 1994 Tyee Fire, condition and trend transects revealed that several areas were beginning to show slight improvement in conditions. However, native bunchgrass ranges are slow to recuperate due to low annual precipitation as well as low soil production, so improvements in condition will take some time.

Some riparian areas were recently fenced to protect them from soil compaction, lowered stream bank stability and erosion. In time, these areas are also expected to improve in condition (in terms of good, fair, and poor) as well as in trend, meaning the area is in an upward (improving) trend rather than a downward (degrading) trend. However, if distribution practices are not improved and managed diligently, the Forest Service expects a downward trend and poorer range condition to result.

After the Tyee Fire, most of the burned areas were seeded during a "Burned Area Emergency Rehabilitation" effort and the Allotment was closed to grazing until further notice. There is a set of criteria that must be met prior to livestock re-entry (included within this Appendix as item G-4). Once these criteria have been met, livestock will be permitted to return. However, adjustments may need to be made in grazing numbers. Prior to re-entry, a capacity determination will be made on the level of livestock grazing that will be allowed on the Allotment. It is our expectation that a reduction of numbers will be higher initally and will decrease over time.

Many of the range improvements were destroyed in the Fire. Many, however, were not in proper working order or in good repair at the time of the Fire.

Noxious weeds (predominately knapweed) as well as other undesirable weedy plants are becoming increasingly invasive in many range areas. This is especially prevalent around areas of high concentration, such as watering holes/riparian areas or corrals. Additional past disturbances, including logging and road building, have aided in the further advancement of noxious weeds.

Existing Condition of the Mosquito Ridge Sheep and Allotment

Three vegetation types grow on the Allotment; timber, meadow, and grassland, with the timber and meadow types predominating. The grasses include a mixture of increasers, decreasers, and invaders. Increasers are a plant species native to a site which increase in relative amount, at least for a time, under heavy use. Decreasers are those grasses native to a site which decrease in relative amount, at least for a time, under heavy use. Invaders are those grasses that are absent or only minimally present in the original vegetation and which invade or rapidly increase following disturbance or continued heavy grazing. Those grass species found within the Allotment and classified as increasers are as follows: Sandberg bluegrass (*Poa Secunda*), Meadow sedges (*Carex* Spp.), Pinegrass (*Calamagrostis rubescens*), and Junegrass (*Koleria cristata*). Those grass species found within the Allotment and classified as decreasers are: Elk sedge (*Carex geyeri*), Bluebunch wheatgrass (*Agropyron spicatum*), Beardless Bluebunch wheatgrass (*Agropyron inerme*), mountain brome (*Bromus carinatus*), and Idaho fescue (*Festuca idahoensis*). Those grass species found within the Allotment and classified as invaders are: Kentucky bluegrass (*Poa pratensis*), Redtop (*Agrostis alba*), and Timothy (*Phleum pratense*). The most common grass species found in the Allotment are elk sedge, Bluebunch wheatgrass, and Sandberg bluegrass.

Of the 11,600 acres in the Mosquito Ridge Allotment, only 6,900 acres are considered suitable for grazing. Most of the range is considered unsuitable due to the soils and watershed values (mainly steep slopes and erosive soils).

The range condition on the Allotment is considered mostly fair with some areas in poor condition. The areas in poor condition are mostly bedding areas or trailing routes (for a full description of the term "range condition," refer to the Existion Condition discussion of the Potato Creek Allotment).

In the 1994 Tyee Fire, 4,000 acres of the Allotment were burned. Most of this area was burned with light to moderate intensities and the vegetation is expected to recover well. It was partly seeded during the "Burned Area Emergency Rehabilitation" efforts. This area is closed to grazing until further notice. The unburned area was unaffected and grazing continues with a new routing schedule. This burned area, like the Potato Creek Allotment, must also meet the criteria (included with this Appendix as item G-4) that have been established for livestock re-entry into the Allotment.

Noxious weeds (predominately knapweed) as well as other undesirable weedy plants are increasingly invading many range areas. This is especially prevalent around areas of high concentration such as bedding grounds, trailing routes, and watering areas. Additional past disturbances, including logging and road building, have aided in the further advancement of noxious weeds.

Future Range Program

Grazing is expected to continue throughout both allotments. Animal numbers may fluctuate and terms of the current permits may change according to management direction.

A more intense range management program is needed in order to improve the condition of the range and meet Forest Plan Standards.

Desired Conditions for the Allotment
** To get 80 percent of the key use areas in good to satisfactory condition ** Utilization of less than or equal to 30 percent in riparian areas or range areas in unsatisfactory condition. ** Zero to 50 percent utilization on good condition sites on the upland. ** Utilization of shrubs between 0 to 30 percent, with all the use occurring before June 30. ** Better distribution of livestock throughout the Allotments and decreased concentrations in riparian areas. ** To ensure all improvements are operational and in good repair. ** To ensure range improvements are not located within riparian zones or other areas of key resource value. ** To confine noxious weeds to roadways only.

Cooperation between the Forest Service and permittees is imperative for the success of improving our rangelands on the National Forest.

Potential Suitable Range - Cattle and Horses

Acres of Primary and Secondary Range by Fish Production Unit (FPU)*

Watershed/FPU	Total Area of FPU	Primary Range (Acres)		Secondary Range (Acres)	
		All Other Aspects	South Aspect	All Other Aspects	South Aspect
ENTIAT - Lower					
Lower Entiat	24,708	739	215	10,388	5,675
Mills-Dinkleman	7,630	259	22	3,145	222
Roaring-Tamarack	16,294	1235	244	4,288	604
Mud Creek	14,427	1672	1146	6,198	3,074
Stormy-Potato	12,033	1359	1156	1,511	1,141
Lower Mid-Entiat	23,833	2162	1227	6,289	2,867
ENTIAT - Middle-Upper					
Brennegan-Preston	7,559	864	520	336	113
Upper Mid-Entiat	14,913	2012	1056	2,108	734
Lake-Silver-Pope	14,611	3775	1825	2,308	945
Three Creeks-Tommy	12,542	2936	1032	2,011	620
North Fork Entiat	17,643	1971	1047	3,803	1,790
Upper Entiat	17,761	2325	1155	1,860	902
Headwaters Entiat	25,881	3202	1261	3,360	1,090
MAD - Lower					
Lower Mad	18,020	1935	640	5,021	1,921
MAD - Middle-Upper					
Middle Mad	10,628	1478	693	2,579	990
Upper Mad	16,852	4512	2320	2,632	1,326
Headwaters Mad	12,851	3372	1325	3,788	1,307
COLUMBIA RIVER					
Swakane-Spencer	32,070	788	612	10,004	6,403
Ribbon Mesa	10,884			4,739	2,402
Navarre Coulee	11,944			6,105	2,954
TOTALS	**323,084**	**36,595**	**17,494**	**82,474**	**37,079**

Table G-3.2

Potential Suitable Range - Cattle and Horses
Acres of Primary and Secondary Range by FS Watershed

4/23/96

Watershed	Primary Range (Acres)		Secondary Range (Acres)	
	All Other Aspects	South Aspect	All Other Aspects	South Aspect
Entiat	24,510	11,904	47,606	19,776
Mad	11,297	4,978	14,020	5,544
Columbia River Tribs.	788	612	20,848	11,758
TOTALS	**36,595**	**17,494**	**82,474**	**37,079**

Footnote Description for Tables G-3.1 and G-3.2
Cattle and Horses Potential Suitable Range Table

The following matrix was used to develop the potential suitable range map for cattle and horses for Version 2.0 of the Entiat Watershed Assessment. Acre values for each "range/aspect" combination were developed for both by FS watershed (Entiat RD) and by fish production unit (FPU).

Suitable Range Criteria **

Cattle & Horses

Historic Vegetation*	Pri/S	Pri/Oth	Sec/S	Sec/Oth***
Grassland	Y	Y	Y	Y
Rocky Grassland	Y	Y	Y	Y
Transition (<5,000')	Y	Y	Y	Y
CLOSED FOREST DF Forest Series All Others	 No No	 No No	 Yes No	 Yes No
Rocky Meadow	Y	Y	Y	Y
Subalpine Meadow (>5,000') (Forest Transition)	Y	Y	Y	Y

* Historic vegetation types as derived from soil survey interpretations.

** Physical suitability criteria defined as follows:

Primary Range:	Less than ½ mile from water Slopes less than 35 percent
Secondary Range:	Greater than ½ mile from water Slopes less than 50 percent

***
Pri Primary Range
Sec Secondary Range
S South Aspect
Oth All Other Aspects

Appendix G-4

Range Allotment Criteria for Livestock Reentry

This assessment is to address the criteria that need to be met prior to livestock grazing of the Potato Creek and Mosquito Ridge Allotmentsfollowing the 1994 Tyee Fire. The criteria identified are soil, water, and vegetation. The conditions of each must indicate adequate recovery of the area.

Soil Resources - *The soil conditions necessary to reintroduce livestock are in reference to erosion control. An adequate litter cover is the most effective condition to decreasing runoff and increasing infiltration.*

According to the Forest Plan, "the minimum percent effective ground cover following cessation of any soil-disturbing activity is 40-60 percent ground cover for moderately erosive soils, 60-75 percent ground cover for severely erosive soils, and 75-90 percent ground cover for very erosive soils." These guidelines refer to two years post disturbance (they are slightly lower the first year).

Studies in the Intermountain and Northern Rocky Mountains areas have shown that at least 60-70 percent ground cover (vegetation, litter, and rocks) is necessary to protect mountain slopes from excessive runoff and erosion during moderately high-intensity summer storms. Some areas of Region VI do not provide 60 percent cover, even under natural conditions. Attainment of >60-70 percent ground cover in this area is unlikely due to soil moisture conditions and past disturbances. Each site or area must be evaluated on its own, individual characteristics to determine the amount of vegetative and ground cover needed to maintain soil stability.

Water Resources - Riparian Health - *The water conditions necessary to reintroduce livestock relate to riparian recovery and disturbance.*

All water developments need to be located out of the riparian zone. Water developments will be scheduled for replacement and will be functioning.

Forest Plan standards and guidelines for floodplain/riparian vegetation, where the following exists, will be maintained: ≥90 percent vegetative ground cover provided by trees, shrubs, grasses, sedges, and duff within the floodplain and true riparian zone to guard against bank erosion, increasing water temperatures, siltation into streams, and destruction of fish habitat.

Existing riparian areas lack mid-level shrub components (e.g., snowberry). Healthy vegetative cover is needed to improve system response to increased streamflows and its ability to buffer sediment input. In order to improve riparian area function: 1) mid-level shrubs need to drastically increase, 2) there is a need for improved vigor of existing tall shrubs; and 3) there is a need to improve streambank vegetative cover.

Vegetation - *The vegetative conditions necessary to reintroduce livestock relate to range plant recovery.*

Perennial grassess (decreasers and increasers) must be present in a wide range of age classes (seedlings, juveniles and mature/old plants) throughout the Allotment.

Perennials are firmly rooted.

A higher proportion of decreasers/increasers (more palatable grasses) must be filling in rather than invaders or exotics (less palatable grasses, e.g., cheatgrass)

Noxious weeds throughout the Allotment must be confined to the infested areas. If monitoring results indicate that spread is occurring in new areas (such as south-facing slopes), this could delay reintroductions until noxious weed control measures are implemented.

Management Concerns

Soils

Grazing before soil readiness can result in soil compaction, puddling, and erosion. Soil is especially vulnerable to damage early in the season as a result of high soil moisture.

Soils should be firm before grazing is permitted. Grazing, when soils are too wet, will result in some or all of the following:

1. Excessive compaction resulting in a hard pan surface that is impervious to moisture penetration.
2. Sod being broken on mountain meadow or bluegrass bottoms.
3. Physical damage to roots of perennial forage plants, especially on bunchgrass ranges.
4. Seedlings being pulled out of the ground.

Water

Riparian areas are of major concern. Livestock will continue to return to these areas as the grazing season continues.

The current grazing season appears to be too long. According to monitoring records, the riparian areas are exceeding Forest Plan Standards by mid-September. In the latter part of the grazing season, the livestock begin to switch from grasses to shrubs. Late summer grazing (from August 15 onward) of riparian shrubs does not allow shrubby vegetation to recover and maintain good vigor for the next year's growth. Continued late summer foraging of shrubs will reduce the mid-level shrub component of riparian structure.

The Allotment may need a new rotation schedule, in order to maintain riparian vegetation structure.

Vegetation

Adjustments may need to be made in grazing numbers. Prior to re-entry, a capacity determination will be established regarding the level of livestock grazing on the Allotment. It is our expectation that a reduction of numbers will be greater, initially, and will decrease over time.

Level of livestock/wildlife competition not yet known.

Improvements

Approximately 20 miles of fences, which are needed to control livestock, must be in place prior to livestock re-entry. A major reconstruction effort will need to be implemented prior to livestock entering the Allotment. Normally, with cooperative efforts, the Forest Service will provide the materials and the permittees will install the improvements.

Appendix G-5

Historical Allotment Map Information

1926 Map

Allotment	Permittee	Numbers	Spc.	Season of Use
Chelan Ridge	George Hendricks	2,000	S	
Tyee Mountain	A. A. Bousquet	1,221	S	
Gold Ridge	George Harder	4,000	S	
Mills Canyon	George Harder	4,000	S	
Tamarack Corral	Squillchuck Sheep Co.	516	S	
		12,137		

1927 Map

Allotment	Permittee	Numbers	Spc.	Season of Use
Chelan Ridge	George Hendricks	2,000	S	6/1 - 9/30
Twenty-Five Mile Cr	George Hendricks	1,000	S	7/1 - 9/30
Tyee Mountain	Not Used			
Gold Ridge	Harder Bros.	2,400	S	5/16 - 6/30
Mills Canyon	Harder Bros.	1,200	S	5/16 - 6/30
Tamarack Corral	A. A. Bousquet	1,678	S	4/1 - 7/31
		8,278		
Potato/Stormy	George Brown	65 & 6	C & H	

1928 Map

Allotment	Permittee	Numbers	Spc.	Season of Use
North Chelan Ridge	George Hendricks	2,000	S	7/1 - 9/30
Twenty-Five Mile Cr.	George Hendricks	1,000	S	6/1 - 6/30
South Chelan Ridge	George Hendricks	1,000 1,000	S S	5/1 - 5/30 5/1 - 6/30
Gold Ridge and Mills Canyon	George Harder	2,400	S	5/16 - 7/24 9/1 - 10/15
Mad River	Harder Bros.	2,500	S	7/25 - 8/31
Tamarack Corral	A. A. Bousquet	1,675	S	4/1 - 7/31
		7,875	S	10/1 - 11/30

1938 Map

Allotment	Permittee	Numbers	Spc.	Season of Use
Chelan Ridge	H. R. Kuhn	2,000	S	5/16 - 9/30 6/1 - 9/30
Gold Ridge	Harder Bros.	2,400	S	5/16 - 9/30
Tamarack Corral	Frank Morse	1,150	S	5/1 - 8/30
Potato Creek	George Brown	85	C	5/1 - 10/31
Swakane Canyon	Baldwin Bros.	30	C	5/1 - 10/15
		12,137		

1922 Grazing Inspection Reports

Allotment	Permittee	Numbers	Spc	Season of Use
Mad River	J.W. Bonar	50	C	7/1 - 10/15
Mills Canyon	Hans Harder & Son Kahlotus, WA	1,000	E/L	5/15 - 7/10
Tyee Mountain	Rothrock Land and Livestock Co. Spokane, WA	800 400	E/L DS	5/16 - 10/15 5/16 - 10/15
Gold Ridge (Indian Creek)	Hans Harder & Son Kahlotus, WA	1,000 1,400	E/L DS	6/1 - 7/1 7/2 - 9/30
Tamarack Corral	Squillchuck Sheep Co. Wenatchee, WA (six small owners)	1,038	E/L	5/16/ - 10/15
Swakane Sheep	Mrs. Paul Laugier Yakima, WA	2,400	E/L	5/16 - 6/30
Entiat Meadows	George Hendricks Kahlotus, WA	1,250	E/L	7/20 - 9/30
Crow Hill Sheep (Entiat)	George Hendricks Kahlotus, WA	1,250	E/L	5/15 - 10/15
Mad Lake	Hans Harder & Son Kahlotus, WA	1,400	DS	8/1 - 10/1

E/L = Ewe/Lamb
D/S = Dry Sheep

Appendix H
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Recreation Uses

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Appendix H-1

Recreation History
Entiat Analysis Area

1900-1910 Mountain goats hunted on Entiat Mountains. Goats were reported as far south as Tyee Mountain.

1909 Forest Service started the construction of the Entiat River Trail starting at Burns Creek. It took two years to pioneer a route to the glacier.

1916 Cabin at North Fork built by Clint Wolf and used by the Hudson Bay Tapping Co.

1919 Entiat River Road was extended from North Fork to Cottonwood Campground. The crew foreman was Riley Albin, and they constructed at a rate of 100-300 yards per day. Road construction enhanced dispersed recreation. During this approximate time period, the Silver Creek area along Entiat River was becoming a popular destination and camping area.

1923 Gilbert Brown began frequenting the Silver Creek area and developing areas for people to camp. An attendance estimate of 10-15 groups/families per weekend was made by Don Roundy.

1925 Volunteers began stocking high mountain lakes with trout. It is uncertain which lakes were stocked, however Ice, Larch and Myrtle Lakes would have been obvious choices.

Early 30's Shetipo, Duncan Hill (Charlie Duncan), and Klone Peak Trails built along with their respective lookouts. Trails were immediately used for recreation although estimates from Mr. Roundy are about two to three per day on weekends and six per day during hunting season.

- Klone Peak (meaning 3) was named by Forest Supervisor A.H. Sylvester (1908-1931) after a dog that he paid three dollars for.

- Billy Ridge and Billy Creek were named after shepherder Billy Knox. Herders also named Medicine Ridge, Mosquito Ridge and Garland Peak.

- The name for Pomas Creek was submitted by Ranger Jim Mckenzie. Pomas means apple and there were no apple trees anywhere near here. There are, however, large deposits of pumice from Glacier Peak. Mr. Mckenzie's intention was to name this Pumice Creek, but it was either misspelled or altered when recorded on a map.

- Harder 1 and Harder 2 Trails were named after sheepherder Bill Harder.

1930 Don Roundy's brother stationed on top of Tyee before lookout was built two years later. Don packed materials up and would encounter about four to five people per day on weekends hiking along trail.

Mid-Late 30's Guest ranches established up at Lucerne and in the upper valley. Formation of trail crews to keep phone lines and trails open to lookouts and allow access to fires. Deer population rises and hunting becomes more popular in valley. The CCC provided labor for building

Cottonwood G.S., Steliko Barn, and the widening of the Entiat River Road from Silver Falls to Cottonwood.

The Hunters trail shelter was constructed by Al Moltke, Walt Gibbons, Jimmy Gibbons, Russ Burnette, Clarence Hilger, and Bill Beany and was used as a hunting cabin. Moltke shot a big four-point buck while they were building the cabin so they named it the Four-Point Camp.

Early 40's Addition of roads up to Maverick Saddle and Shady Pass instituted dispersed recreation into the Valley.

1946 Ski Hill developed at Dill Crk. This drew about 50-75 people per day.

Late 40's Development of self-contained camp trailers resulted in an increase in dispersed recreation and camping. Cabin at North Fork removed by Haven Stanaway.

1950's North Fork Road built for logging. Sheep were transported via ferries on the Columbia River.

During the late 50's, motor bikes (tote Goats) started showing up along forest trails.

June 30, 1961 Mad River Dude Ranch lease ended, and on July 1, 1961, Les Julian started as the first Blue Creek Guard.

70's and 80's Motor bike trail use begain to sky rocket.

1990 Forest Plan signed, closing the North Fork to Motorized Travel. Blue Ribbon Coalition and North West Motorcycle Association sues to keep area open. Closure enforced in 1993.

Appendix H-2

Existing Conditions - Recreation

Overview

The recreation objectives on the Entiat Ranger District are to preserve present and future outdoor recreation experiences, prevent unsanitary conditions, protect water quality, prevent wild fires resulting from recreation actives, to take all reasonable measures necessary to provide for the safety of our recreation users, and to coordinate between differing or competing recreation uses or values so that existing and future recreation will be preserved without adversely affecting other resources.

The Entiat River and major tributaries provide users a diverse recreation experience, ranging from the more developed campgrounds, such as Silver Falls, to the more undeveloped primitive camps within the headwaters of the Entiat River. The forest single track trails also provide the traveler a wide variety of experiences, ranging from the most developed trail, like the asphalted barrier-free trail within the Silver Falls complex, to the more primitive trails, such as 45-Mile Sheep Drive along Borealis Ridge. The Entiat Valley provides a little something for every one, regardless of whether their recreation of choice is car camping, hike-in camping, horse packing or riding, motor bike trail riding, mountain biking on forest trails or roads, mountaineering, or viewing the natural wonders of the valley or surrounding mountain peaks.

Recreational use throughout the Entiat Valley has increased with its development and the proximity of the area to large population concentrations. Societal trends have also influenced its popularity as more individuals and families spend greater amounts of time participating in outdoor activities. Continued use is expected to increase with the further development and migration of people to the area (Figure H-2.1)

Developed Recreation

Current Management Situation

Most of the developed recreation on the Entiat is confined along the main stream of the Entiat River, except for Pine Flats which is along the Mad River. The Entiat Ranger District provides the recreationalists with 107 family-oriented camp sites (see Appendix H-3.1) with all but 11 being fee sites (full service). Also included are two observation points (Box Canyon and Entiat Falls), two summer home tracts with seventeen residents, and two group reservation sites (Silver Falls and Pine Flats). Five full-service campgrounds provide 96 family units, with camping fees ranging from $3.00 to $5.00 per night for each camping vehicle. These sites provide the recreationist with garbage pick-up and centralized hand pump wells. Also managed are 11 Limited Service camp sites (free camping), in three separate campgrounds. These sites provide only limited facilities; no garbage or water are provided.

Over the past decade, recreation use on the District has steadily increased, with weekend visitations currently running over 100 percent capacity. The overflow visitors will camp at many of the dispersed campsites within the Tommy Creek area or on any wide spot along the Entiat Valley Road. Weekday use currently runs at around 50 to 60 percent during the heavy summer-use period (July through August). Silver Falls complex is the most popular recreation area that this facility provides, with 29 family camp units, 1 reservation group site, 1.4 miles of National Recreation Trail and a 1.3-mile Barrier Free Interpretive Trail. Silver Falls Campground currently receives approximately 27,000 annual visits and the National Recreation Trail receives an additional 6,000 visits annually.

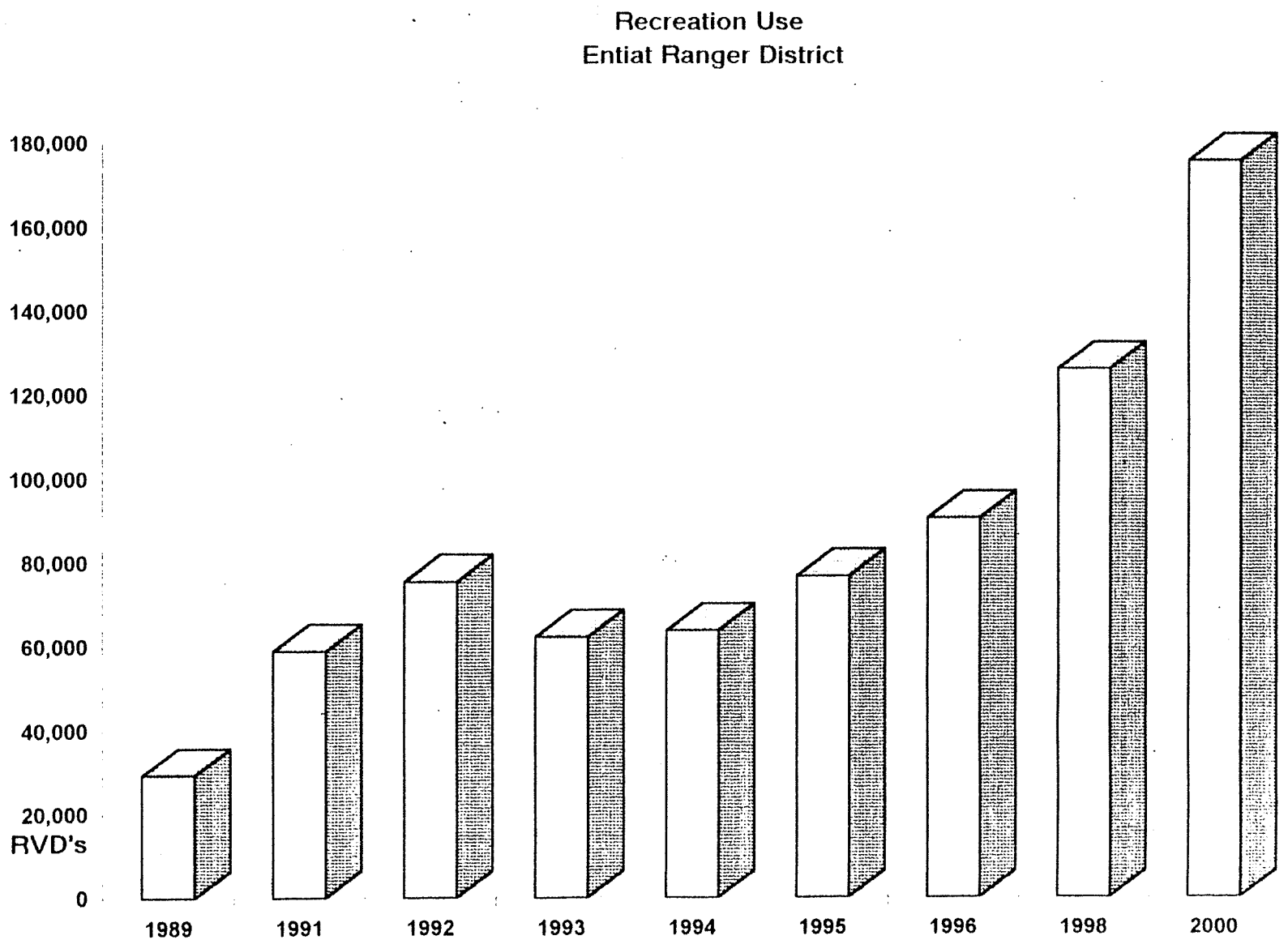

Figure H-2.1 **Recreation Use - Past and Projected.** Entiat Ranger District.

The current facilities condition of the District Recreation facilities ranges from good to poor, with the limited service campgrounds being in a less-than-desirable condition, along with portions of the Cottonwood Campground. These areas have extensive vegetation loss that, in some cases, runs to the River's edge. Fox and Lake Creek Campgrounds were expanded and upgraded in the Late 80's, and the popularity of these two camps continues to grow.

While current funding levels drop in recreation and our population continues to grow, so does the demand for quality recreation facilities in our forest environment. Performing routine maintenance and facility upkeep is very difficult. Currently the District is being forced into people management rather than facility management.

Recreation Trails

Current Management Situation

The Entiat Ranger District provides the "trail traveler" with a wide range of recreation experiences. Currently, the District manages 292 miles of forest single track trails. This system is divided into three differing management areas; Wilderness Trails-65 miles, Non-Motorized Trail system-35 miles, Multiple-Use Trail system-184 miles, and 6.5 miles of Hiker Only Trails (see Appendix H-3.3)

Wilderness Trails

These trails are closed to all mechanized modes of travel. This trail system all lies with in the headwaters of the Entiat drainage and consists of 65 total miles, with 41 miles being standard maintenance class and 24 miles being in less-than-standard maintenance class (see Appendix H-4). The main access route into this trail system is from the Entiat River Trailhead at Cottonwood, up the **Entiat River Trial #1400.** This Trail serves as the main portal into the Glacier Peak Wilderness, with the first 3.6 miles being multiple use, and the Wilderness boundary occurring at 4.2 miles. This trail is enjoyed by many types of user including equestrians, backpackers, day hikers, fishermen, mountain bikers, two- wheeled motorized travelers, and the occasional llama packer. The Entiat River Trail is traveled by almost everyone that camps in the nearby Cottonwood Campground; over 60 percent of the travelers along this Trail only go to Myrtle Lake. This makes the first 3.6 miles that leading into the Wilderness very congested, causing conflicts between differing user types. This is one of the most diverse and heavily-used Trails on the Entiat Ranger District.

Popular destination spots within the Entiat's portion of the Glacier Peak Wilderness area are Larch Lakes, Ice Lakes, Entiat Meadows and Entiat Glacier. (See Appendix H-3.2 regarding percent of use at destination spots in the Upper Entiat Trail area).

Non-Motorized Trail System

This trail system lies primarily in the North Fork of the Entiat River, consisting of a total of 35 miles, with 23 miles being of standard maintenance level and 12 miles being less then standard. Prior to the 1990 Wenatchee National Forest Land Management Plan, this trail system was managed as multiple use with motorized travel being allowed. The Forest Service was sued by the Blue Ribbon Coalition and North West Motorcycle Association to keep area the area open. In 1993, the closure was enforced. This trail area is very popular with the equestrian traveler, camping in the many meadows the area provides. The North Fork Trail provides the only access into Fern Lake, which is a very popular high mountain fishing lake.

Multiple-Use Trail System

The Multiple-Use trail system managed by the Entiat consists of the hub of one of the largest and most unique systems of interconnecting trail networks in the northwest, **consisting of over 235 miles,** with 184 of these miles being located within the Entiat Ranger District's boundary. This system is primarily use by the motorized recreationalists, but is also enjoyed by hundreds of mountain bikers, equestrians, hikers and the occasional llama packer (see Appendix H-3.4). This system travels over and through two mountain ranges and into three valleys, (Lake Wenatchee to Lake Chelan) and the trails range in difficulty levels for the beginner to the most experienced trail user. Education and enforcement contacts made over the last five years have shown that

over 50 percent of the users of the area enter from off district, with the majority coming from the Lake Wenatchee District. More then 53 percent of all use along District Multiple-Use trails come from Western Washington (see Appendix H-3.5 where our users call home)

The overall condition of this system is very good, this is mainly because many of the trails and facilities along this multiple-use trail system on the Entiat Ranger District have been developed, or redeveloped to standard, primarily within the last fifteen years. This a direct result of funding grants, received from the Washington State IAC (Inter-Agency Committee) NOVA Non-Highway and Off-Road Vehicle Activities) program, that **exceed three quarters of a million dollars.** Currently ⅔ of the trail maintenance funds for this system come from the Washington State IAC. This program has enabled the District to reduce its backlog of less-than-standard maintenance levels (see Appendix H-3.6). This system also receives hundreds of volunteer hours from organized user groups to upgrade degraded sections of trail.

What attracts recreationalist's to this area? The upper Mad River area is the most popular destination within this system. This area provides users with four mountain lakes and meandering streams that provide good fishing. Additionally, it contains ridge lines and peaks that overlook many areas in the Entiat Valley, or have views of Glacier Peak and Mt. Rainier. It also contains many miles of quality recreation trails and provides hundreds of acres of vast meadows, creating excellent grazing for recreational stock, and superior wild flower viewing.

With the gentle nature of this area and trails that have limited exposure to danger, it attracts many family-orientated trail travelers, including those motor Biking, mountain biking, horseback riding, or hiking. This can create conflicts between differing uses and user values.

Dispersed Recreation

Current Management Situation

Dispersed camping is scattered through out the Entiat Valley. These dispersed areas provide opportunities that are very different than those in developed campgrounds. Users of these areas desire privacy, lack of development, lower use levels, and the freedom to alter campsites to suit their objectives. Currently, the District has an estimated 250 dispersed camps, 200 of which are mapped. Only the camps within the Wilderness have extensive impact surveys completed. Most camps throughout the District are concentrated around water, whether its around lake, streams or rivers or adjacent to developed campgrounds.

Known areas with concentrated camps are: Entiat Meadows, Larch Lakes, Ice Lakes, Mad Lake, Tommy Creek area, Mad River/Tillicum Creek Corridor.

Winter and Other Recreation Activities

Current Management Situation

Winter recreation (consisting of mainly snowmobiling) is one of our fastest-growing recreational activities. This is mainly due to the congestion that other winter recreation areas are currently receiving. Currently, the Lake Wenatchee R.D. grooms the route from Eagle Creek along Entiat Ridge to Sugarloaf Lookout; and Chelan R.D. grooms the route up 25-Mile Creek over Shady Pass and down the Sno-Park ½ mile above the forest boundary sign along the Entiat River Road. Another popular area in the Valley is Tyee Ridge, which over-the-snow travelers are discovering. Users are attracted to this area because of the vast open playgrounds created by logging and the 1994 Tyee Fire. Winter recreation use varies from area to area; our highest use area is along the Entiat Ridge, where recreationalists riding on the Lake Wenatchee system come over to the Entiat Side to enjoy the wide open playgrounds. Lake Wenatchee currently estimates that on a busy weekend, 2,000 snowmobiles use their system daily, and it is estimated that approximately 25 percent of this use comes over to the Entiat side. Currently, it is very difficult to estimate use in other portions of the District.

Other Recreation Activities

Includes hunting, fishing, and site seeing from forest roads and trails. Currently, we do not have any use figures for these other forest uses, however, in 1996, an extensive use monitoring system will be initiated.

Developed Campgrounds

Campground	Number of Sites	Services Available
Cottonwood	25	• 2 centralized hand-pump wells • 6 old-style pit toilets • administrative guard station with barn and corral • garbage service
Three Creeks	3	• 2 old-style pit toilets • no garbage service
Spruce Grove	2	• 1 old-style pit toilet
North Fork	8	• 1 hand-pump well • 2 old-style pit toilets • garbage service
Silver Falls	29	• 7 newer vaulted toilets • 2 hand-pump wells • guard station with outbuildings • garbage service
Lake Creek	18	• 2 composting toilets • 4 old-style pit toilets • 1 hand-pump well • garbage service
Fox Creek	16	• 2 vaulted toilets • 1 composting toilet • 1 hand-pump well • garbage service
Pine Flats	6	• 3 old-style pit toilets • 1 hand-pump well
Box Canyon Viewpoint		• congested parking for 4 vehicles • 2 old-style pit toilets
Entiat Falls Viewpoint		• parking for 10 vehicles • no toilets
Riverside Summer Homes		• 8 residents
Pope Creek Summer Homes		• 9 residents

Table H-3.1 **Developed Campgrounds.** Entiat Ranger District.

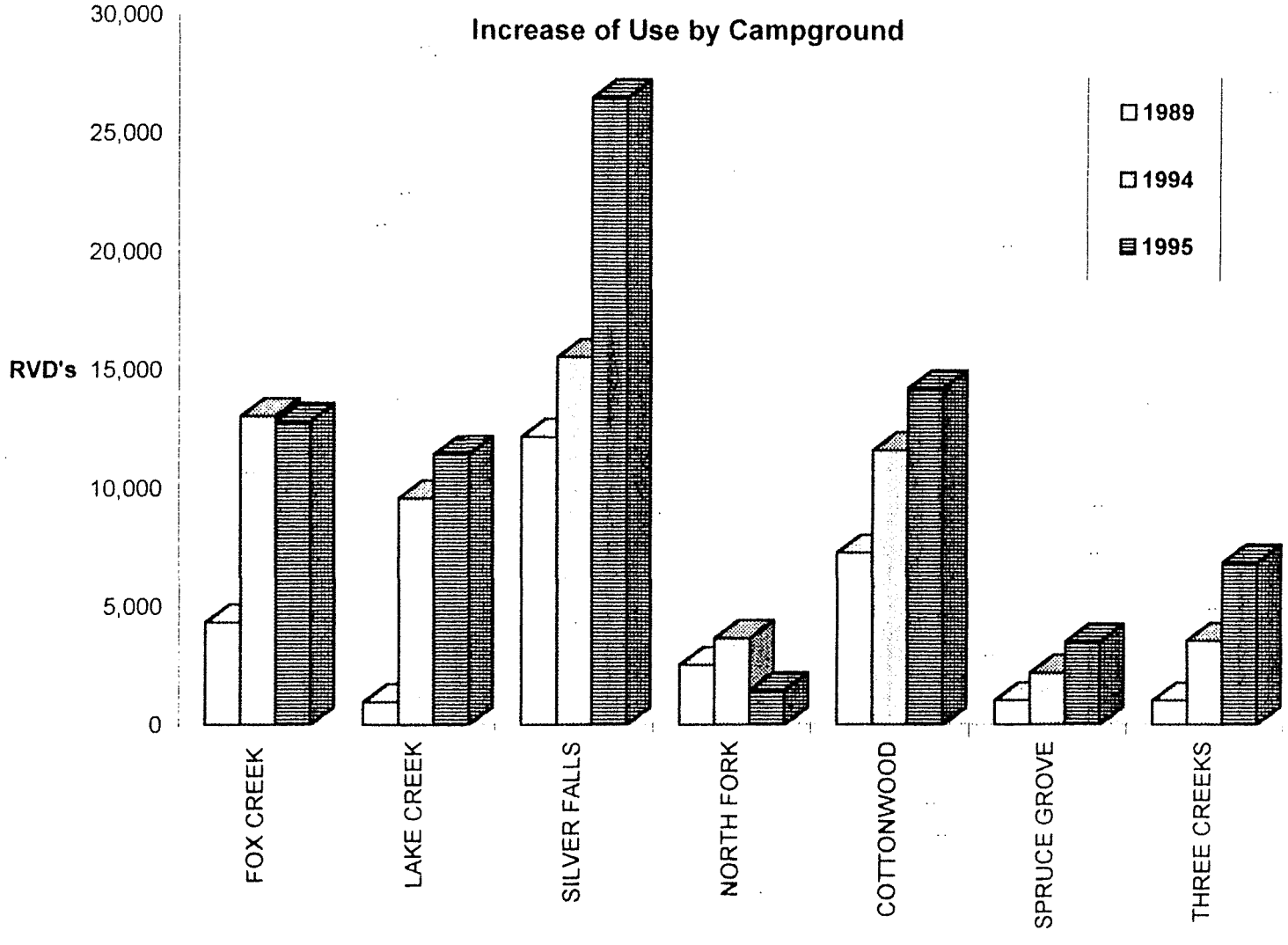

Figure H-3.1a **Increase of Use by Campground.** Entiat Ranger District.

Trailheads

LOWER MAD RIVER TRAILHEAD is located in the Pine Flats Campground approximately five miles up Mad River Road #5700. This trailhead has a one way drive-through road that also accesses Pine Flats Campground. Facilities at the trailhead include two pit toilets, information bulletin boards, associated trail termini signs, a registration station, loading ramp, and a horse hitch rail. It has a capacity for eight vehicles.

MAVERICK SADDLE TRAILHEAD is located on the District border of the Lake Wenatchee and Entiat Ranger Districts, at the road junctions of 6101 on the Lake Wenathctee and 5700 on the Entiat Ranger District. This trailhead has both an upper and a lower parking area. The upper has pull-through parking with a capacity for six vehicles with trailers. The lower parking area has one-way access with parking for six vehicles (trailers not recommended). Facilities at the lower parking area include information bulletin boards, associated termini signs, and a visitor registration station.

LAKE CREEK TRAILHEAD is located 28 miles up Entiat River Road #51 just beyond the Lake Creek Campground. This is a small lot style trailhead with a capacity of six vehicles with trailers. Facilities at the trailhead include an information bulletin board, visitor registration station, associated trail termini signs, and one pit-style toilet.

MIDDLE TOMMY TRAILHEAD is located two miles up Tommy Creek Road #5605. This trailhead is a paved cul-de-sac style parking area, with a capacity for six vehicles with trailers. Facilities include an information bulletin board, associated trail termini signs, loading ramp, hitch rails, and a visitor registration station.

NORTH TOMMY TRAILHEAD is located four miles up Tommy Creek Road #5605. This trailhead is an unpaved cul-de-sac with limited parking and turnaround, and parking capacity is very limited. Facilities include an information board, visitor registration station, and associatied trail termini signs.

ENTIAT RIVER TRAILHEAD is located 38 miles up Entiat River Road #51. This trailhead is the largest of the trailheads on the Entiat Ranger District and serves as the portal into the Glacier Peak Wilderness area. The parking area is large cul-de-sac type parking with a capacity for 25 vehicles with trailers. Facilities include associated trail termini signs, loading ramp, stock hitch rails, information bulletin boards, visitor registration station, associated trail termini signs, and a pit-type toilet.

DUNCAN HILL TRAILHEAD is located at the end of Duncan Hill Road. This Trailhead is a small, undeveloped parking area with a capacity for three to four vehicles. Currently, it is very difficult for a rig pulling a horse trailer to turn around. Facilities include associated trail termini signs, a small information bulletin board, and a visitor registration station.

NORTH FORK TRAILHEAD is located at the end of North Fork Road. This Trailhead has a capacity for ten vehicles and around five horse Trailers. It can be very difficult to turn trailers around when the trailhead is close to capacity. Facilities include associated trail termini signs, a loading ramp, stock hitch rails, information bulletin board, visitor registration station, associatied trail termini signs, and a pit-type toilet.

BIG HILL TRAILHEAD is located at the top of Shady Pass on the 5900 Road . This is a small trailhead with a capacity for eight vehicles. Facilities include associated trail termini signs, loading ramp, stock hitch rails, information bulletin board, visitor registration station, and associatied trail termini signs. Not many visitors use this trailhead due to its distance up the steep Shady Pass Road.

Table H-3.2 **Percent of Use at Destination Spots - Upper Entiat Trail Area.** Entiat Ranger District.

5575 visits 1995

45 MILE SHEEP DRIVE	0.25%
5TH OF JULY	0.38%
ANTHEM CREEK	3.29%
COW CREEK MEADOWS	1.65%
DAY HIKING	2.92%
ENTIAT MEADOWS	4.44%
GOPER MT	0.25%
GROUSE CREEK	0.25%
ICE CREEK	0.51%
ICE LAKES	5.70%
LARCH LAKES	11.66%
MILHAM PASS	1.01%
MYRTLE LAKE	61.98%
PINNACLE	0.13%
POMAS PASS	0.25%
SNOW BRUSHY MEADOWS	1.65%
UPPER MAD RIVER	4.31%

MODE OF TRAVEL

HIKE	80.99%
HORSE	7.98%
MOTOR BIKE	5.32%
MTN BIKE	5.71%

The upper Entiat Trail area received approximately 5575 Visits in 1995. It is also estimated that 580 head of recreation pack and saddle stock use this area, per use season (July thro Oct.) with approximately 75% using the Dispersed Camps in and around Entiat Meadow. These use figures are based on 1993 trailhead use samples of 4500 RVD's. From 93 to 94 there was a 5% increase, and a 18%, from 94 to 95.

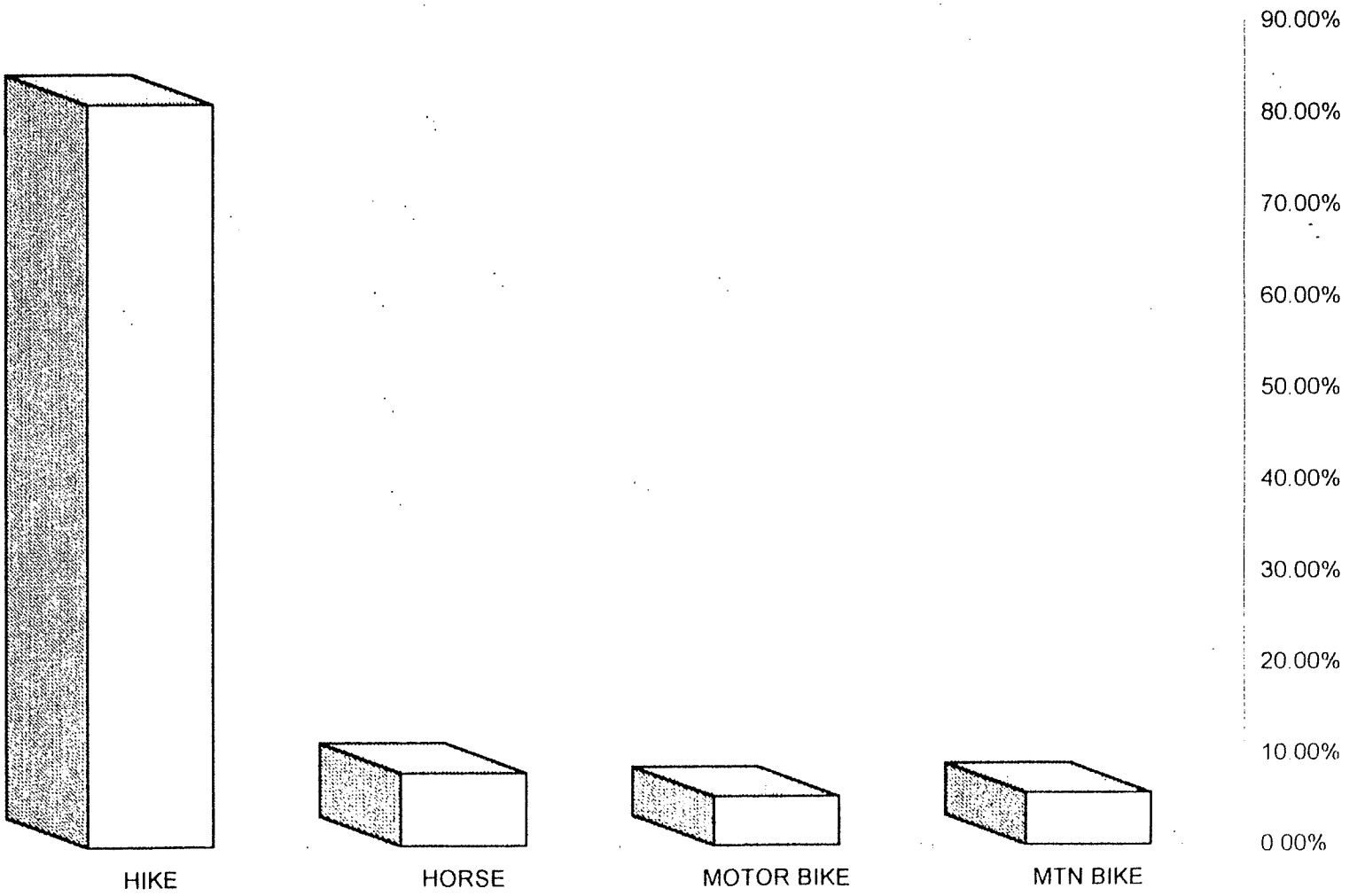

Figure H-3.2a **Mode of Travel from Entiat River Trailhead.** Entiat Ranger District.

Figure H-3.2b **Destination Spots from Entiat River Trailhead.** Entiat Ranger District.

					Relates to Trail Construction and Maintenance Guides		Service Level Miles				
Trail	Trl #	Mgt Area	ROS Class	Inv Mi	Diff	Mgt obj	Mi Standard	Mi Less Than	Seasonal Closures	C Development Fun	IAC Mtc Funds
EMERALD PARK	1230 1	Wilderness	WLD	9	D	PS	3	2			
WILSON CREEK	1231 1	Wilderness	WLD	2 1	M	PS		2 1			
ENTIAT RIVER	1400	Multiple-Use	SFM	3 6	E	PS	3 6				Yes
ENTIAT RIVER	1400 1	Non-Wheeled	SFNM	0 6	E	PS	0 6				
ENTIAT RIVER	1400 2	Wilderness	WLD	10 5	E	PS	9 75	0 75			
ROARING CREEK	1401	Multiple-Use	RN	2	D	MB		2			
MIDDLE FORK	1401 1	Multiple-Use	RN	7 1	M	HB		7 1			
HI LINE	1403	Multiple-Use	SFM	3 5	M	MB	1 75	1 75			Yes
COW CREEK	1404	Multiple-Use	SFM	0 4	E	PS	0 4				Yes
COW CREEK	1404 1	Non-Wheeled	SFNM	1	E	PS	1				
COW CREEK	1404 2	Wilderness	WLD	2 6	D	PS	2 6				
ICE CREEK	1405	Wilderness	WLD	4 1	D	PS	2 5	1 6			
ICE LAKES	1405 1	Wilderness	WLD	2	M	HB	2				
MAD LAKE	1406	Multiple-Use	SFM	0 4	E	PS	0 4			Yes	Yes
GOLD RIDGE	1407	Multiple-Use	RN	3	M	MB		3			
GARLAND PEAK	1408	Non-Motorized	SFM	7	M	PS	4	3			
GARLAND PEAK	1408 1	Wilderness	WLD	4 1	M	PS	2	2 1			
MAD RIVER (Lower)	1409	Multiple-Use	RN	6 1	M	PS	6 1			Yes	Yes
MAD RIVER (Lower)	1409	Multiple-Use	SFM	8 8	M	PS	8 8				Yes
MAD RIVER (Upper)	1409 1	Multiple-Use	SFM	12 2	E	PS	12 2			Yes	Yes
POND CAMP	1409 2	Multiple-Use	SFM	3 7	E	PS	3 7			Yes	Yes
HORNET RIDGE	1410	Multiple-Use	RN	6	M	MB		6			Yes
MINERS RIDGE	1411	Multiple-Use	RN	4 5	E	MB		4 5			Yes
BILLY RIDGE	1413	Multiple-Use	RM	2 5	M	MB	2 5			Yes	Yes
BILLY RIDGE	1413	Multiple-Use	RN	3	M	MB	3			Yes	Yes
BILLY RIDGE	1413	Multiple-Use	SFM	1 5	M	MB	0 5	1		Yes	Yes
TRAILHEAD	1414	Multiple-Use	RN	0 3	E	PS	0 3				Yes
TREE RIDGE	1415	Multiple-Use	SFM	8 7	D	PS	8 7			Yes	Yes
BILLY CREEK	1416	Multiple-Use	RN	3 2	D	PS	3 2			Yes	Yes
BILLY CREEK	1416	Multiple-Use	SFM	3	D	PS	2			Yes	Yes
HUNTER	1417	Multiple-Use	SFM	1	E	PS		1			Yes
COUGAR RIDGE	1418	Multiple-Use	RN	2	E	PS	2				Yes
COUGAR RIDGE	1419	Multiple-Use	SFM	3	E	PS	3				Yes
COUGAR RIDGE	1418 1	Multiple-Use	SFM	1 5	M	MB		1 5			Yes
JIMMY CREEK	1419	Multiple-Use	SFM	3	D	PS	1 5	1 4			Yes
COUGAR MTN	1420	Multiple-Use	SFM	2	M	HB	1	1			
LOST LAKE	1421	Multiple-Use	SFM	4	D	PS	3 9			Yes	Yes
MOTT CREEK	1422	Multiple-Use	RN	1	M	HB		1			
SO TOMMY	1423	Multiple-Use	RN	3	M	MB	1	2			Yes
SO TOMMY	1423	Multiple-Use	SFM		M	MB		2			Yes
MIDDLE TOMMY	1424	Multiple-Use	RN	4	D	PS	4				Yes
MIDDLE TOMMY	1424	Multiple-Use	SFM	4 4	D	PS	3 0	1			Yes
NO TOMMY	1425	Multiple-Use	RN	2	E	PS	2			Yes	Yes
NO TOMMY	1425	Multiple-Use	SFM	7	E	PS	7			Yes	Yes
BLUE CREEK	1426	Multiple-Use	SFM	4 6	E	PS	4 6			Yes	
THREE CREEKS	1428	Multiple-Use	RN	4	D	PS		4			
THREE CREEKS	1428	Multiple-Use	SFM	4 4	D	PS		4 4			
SHETIFO	1429	Multiple-Use	RN	2	M	PS	2			Yes - Spring Only	Yes
SHETIFO	1429	Multiple-Use	SFM	2 2	M	PS		2 2		Yes - Spring Only	Yes
LARCH LAKES	1430	Wilderness	WLD	5 4	D	PS	4 4	1			
COOL CREEK	1431	Wilderness	WLD	5 4	M	PS	2	3 4			

Table H-3.3 **Trail Inventory.** Entiat Ranger District.

Trail	Trl #	Mgt Area	ROS Class	Inv Mi	Diff	Mgt obj	Mi Standard	Mi Less Than	Seasonal Closures	C Development Fun	IAC Mic Funds
45 MILE DRIVE	1432	Wilderness	WLD	4.9	D	HK	2	2.9			
PYRAMID MTN	1433	Wilderness	SPNM	14.6	D	PS	9.6	5			
PYRAMID MTN	1433.1	Non-Motorized	WLD	2.2	D	PS	1.1	1.1			
DUNCAN HILL	1434	Multiple-Use	RN	3	D	PS	3				Yes
DUNCAN HILL	1434	Multiple-Use	SPM	5.1	D	PS	1.2	3.9			Yes
DUNCAN HILL	1434	Non-Motorized	SPNM	2.3	D	PS		2.3			
DUNCAN HILL	1434.1	Wilderness	WLD	3.6	M	PS	1	2.6			
ANTHEM CREEK	1435	Multiple-Use	SPM	3.3	D	PS	2	1.3			Yes
FERN LAKE	1436	Non-Motorized	SPNM	1.7	M	HK	1.5				
NO PERMANENT	1437	Non-Motorized	SPNM	5.5	D	PS	4.4	1.1			
NO PERMANENT	1437	Non-Motorized	RN	2.6	D	PS	2.6				
FLUGH RIDGE	1438	Non-Motorized	SPNM	4.9	M	PS	2.75	2.15			
PYRAMID CREEK	1439	Non-Motorized	SPNM	4	E	PS	3	1			
BUTTE CREEK	1440	Non-Motorized	SPNM	2	M	PS	0.75	1.25			
PYRAMID VIEW	1441	Non-Motorized	SPNM	2.9	D	PS	2.9				
SILVER FALLS NRT	1442	Hiker Only	RN	1.4	D	HK	1.4			Yes	
LAKE CREEK	1443	Multiple-Use	RN	7.6	E	MB	6	1.6		Yes	
LAKE CREEK	1443	Multiple-Use	SPM	3	E	MB		3		Yes	Yes
ANGLE PEAK	1444	Multiple-Use	SPM	4	D	MB		4		Yes	Yes
4 MILE RIDGE	1445	Multiple-Use	RN	2.3	D	MB		2.3		Yes	Yes
4 MILE RIDGE	1445	Multiple-Use	SPM	3	D	MB	3			Yes	Yes
STORM CREEK	1451	Multiple-Use	RN	5.2	M	HK		5.2			
POMAS CREEK	1453	Wilderness	WLD	3.1	M	PS	2	1.1			
STELIKO RIDGE	1454	Multiple-Use	RN	3.8	E	PS		3.8			Yes
SILVER FALLS BAR	1462	Hiker Only	RN	1.3	E	HK	1.3			Yes	
MYRTLE LAKE	1404.A	Non-Motorized	SPNM	0.4	E	PS	0.4				
COW CREEK	1404.B	Wilderness	WLD	0.12	E	PS	0.12				
GARLAND PEAK	1408.A	Non-Motorized	SPNM	0.09	M	PS	0.09				
COUGAR MTN VP	1418.A	Multiple-Use	SPM	0.4	D	MB		0.4			Yes
LONE PEAK VP	1425.A	Multiple-Use	SPM	0.5	D	PS	0.5				Yes
LARCH LAKES	1430.A	Non-Motorized	SPNM	0.7	E	HK	0.7				
LARCH LAKES	1430.A1	Multiple-Use	WLD	0.3	E	HK	0.3				
DUNCAN HILL VP	1434.A	Multiple-Use	SPM	0.5	M	PS		0.5			Yes

REFERENCE TO FOREST SERVICE TRAILS HANDBOOK

DIFF
E=EASY
D= MORE DIFFICULT
M= MOST DIFFICULT

MO
PS= PACK AND SADDLE
MB= MOTORBIKES or 2 WHEELED OHVs
HK= HIKER

TRAIL ATTRIBUTES
WD= WILDERNESS
MU=MULTIPLE-USE (open to All Uses)
NM= NON-MOTORIZED (Closed to Motorized Travel)
NW= NON WHEELED (Closed to Wheeled Travel)

Table H-3.3 **Trail Inventory.** Entiat Ranger District. (Continued)

Table H-3.4 **Multiple Use-Trail Use.** Entiat Ranger District.

Summary of Trail Use by Mode of Travel and Use Area

Visits--(1994 10,703) -- (1995 13,914)

Mode of Travel

4x4 Vehicle	1.33%
ATV's	1.87%
Motor Bikes (ORV's)	59.26%
Equestrian	8.22%
Hikers	12.34%
Mountain Bikes	16.99%

Trail Use by Area

LOWER ENTIAT RIVER	2.85%
ENTIAT VALLEY RD.	1.49%
LAKE CREEK TRAIL AREA	7.17%
LOWER MAD RIVER TRAIL AREA	26.25%
MAVERICK SADDLE	4.49%
PINE FLATS	3.43%
SWAKANE	0.82%
TOMMY TRAILS	2.58%
UPPER ENTIAT RIVER ROAD	0.74%
UPPER MAD RIVER	50.18%

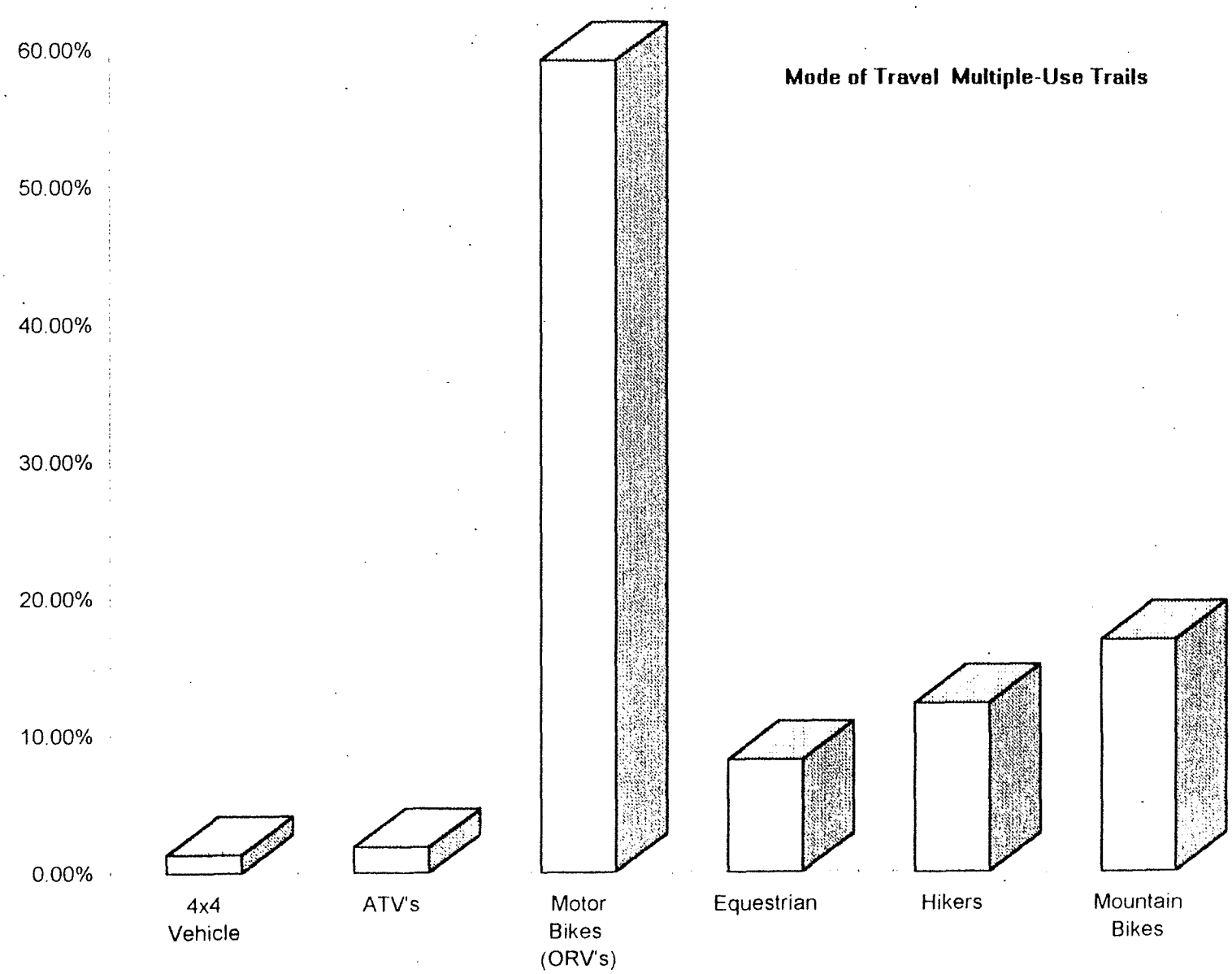

Figure H-3.4a **Mode of Travel - Multiple Use Trails.** Entiat Ranger District.

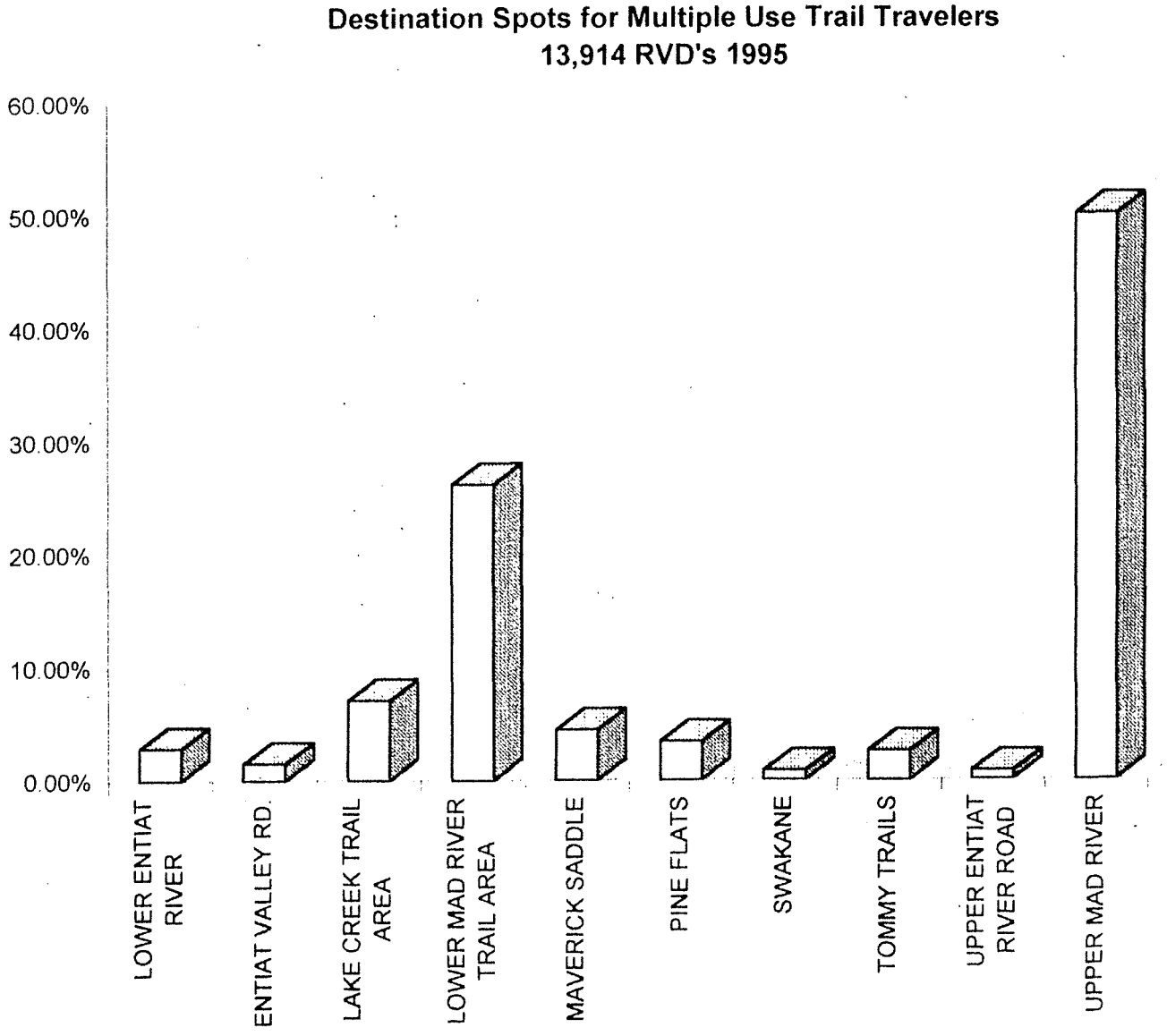

Figure H-3.4b **Destination Spots for Multiple-Use Trail Travelers (1995).** Entiat Ranger District.

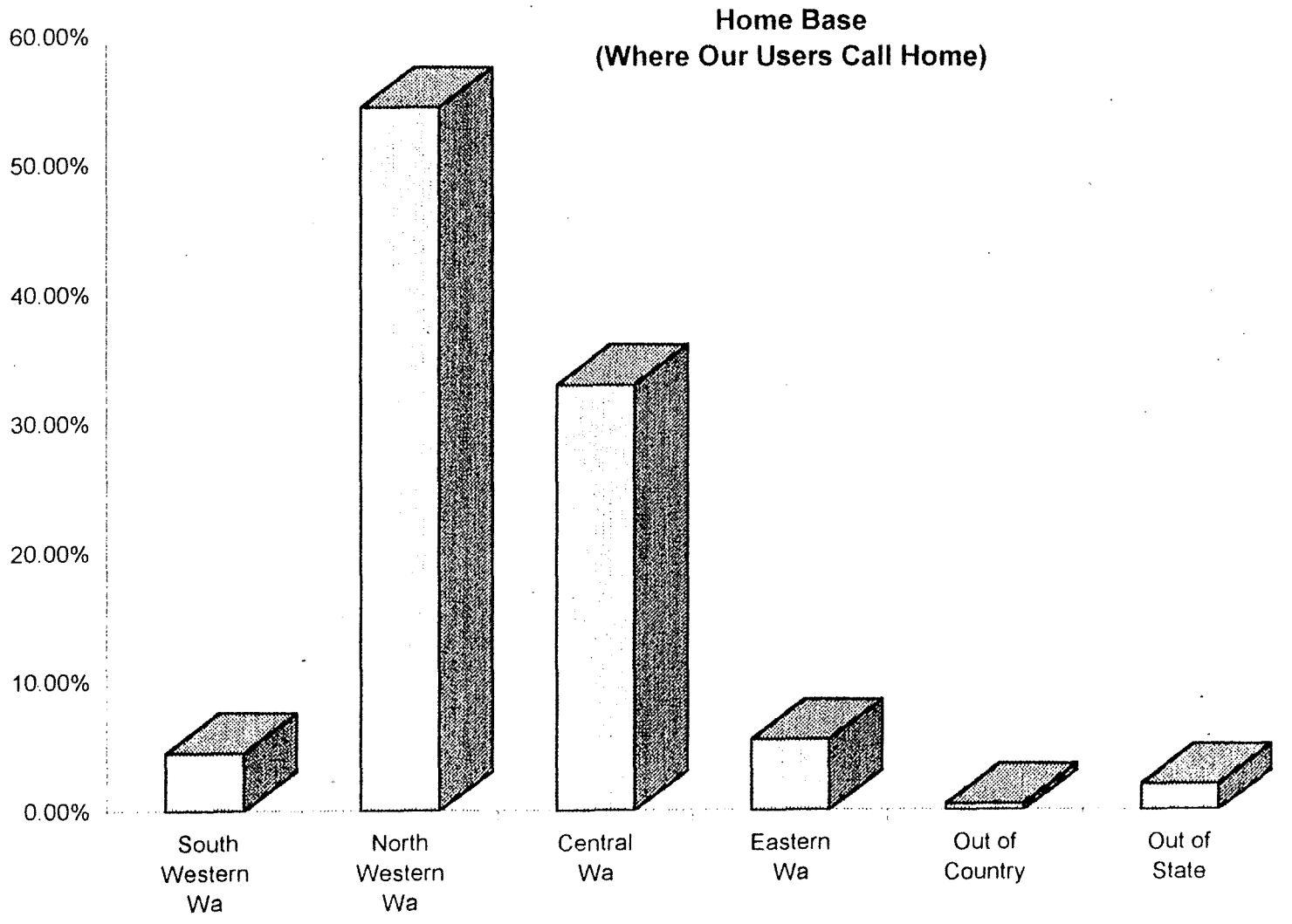

Figure H-3.5 **Home Base - "Where Our Users Call Home".** Entiat Ranger District.

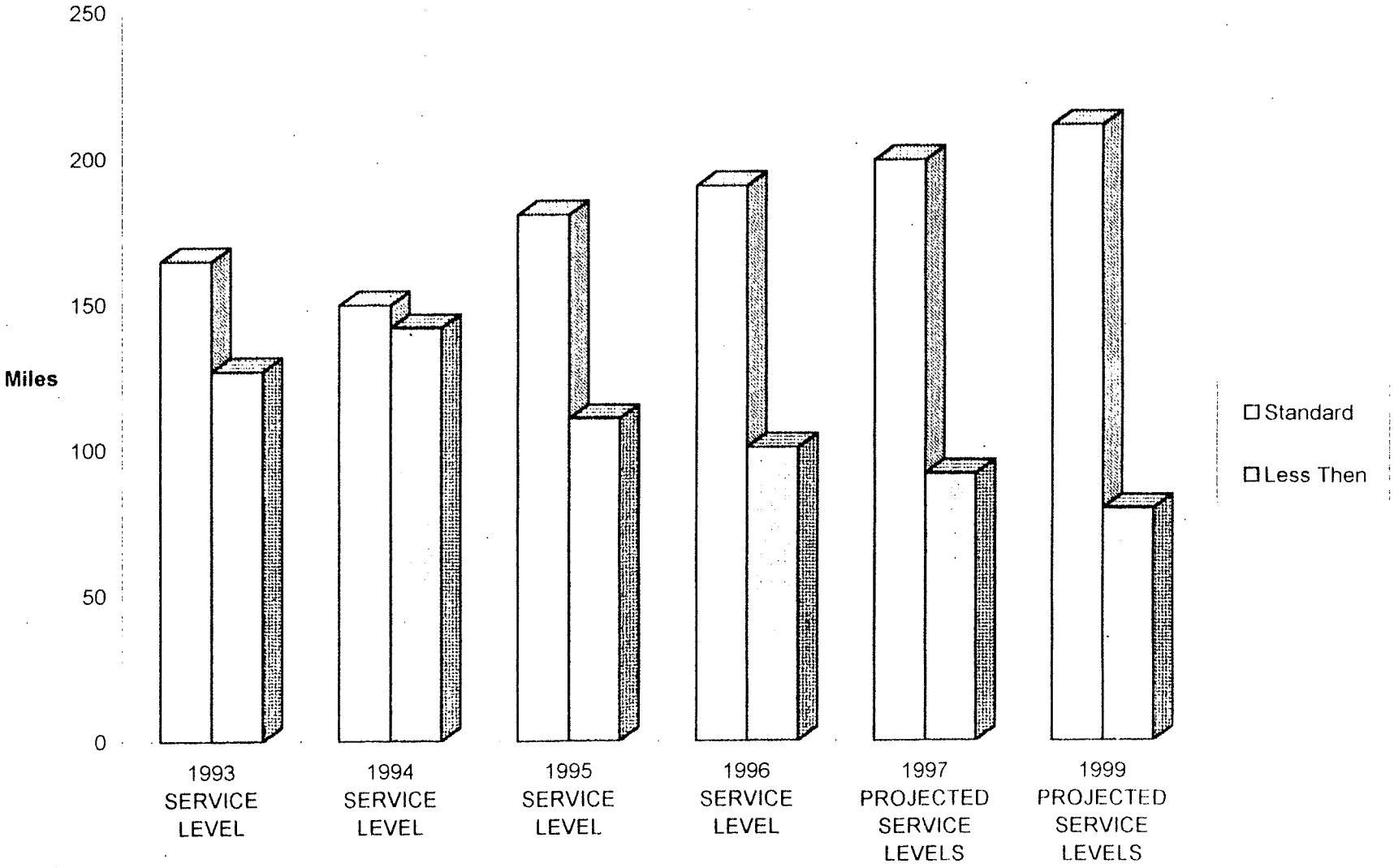

Figure H-3.6 **Trail System Service Levels.** Entiat Ranger District.

Appendix H-4

Recreation Resource Definitions

Difficulty Levels. The degree of challenge a trail presents to an average user's physical ability and skill. Difficulty is a function of trail condition and route location factors, such as alignment. It also includes steepness of grades, gain and loss of elevation, availability of drinking water, and amount and kind of natural barriers that must be crossed. Difficulty levels apply to all the types of trails discussed in the Forest Service Trails Handbook.

Easiest	A trail requiring limited skill, with little challenge to travel.
More Difficult	A trail requiring some skill and challenge to travel.
Most Difficult	A trail requiring high degree of skill and challenge to travel.
Standard Maintenance	(Service Level) Maintenance that is adequate to permit the trail to serve its established objectives.
Less-than-Standard Maintenance	(Service Level) Maintenance under which some work items are not performed, resulting in a trail that does not fully serve established objectives.
An ATV	Any motorized vehicle designed for off-highway use that is 50 inches or less in width, having an unladened dry weight of 600 pounds or less, traveling on three or more tires, and having a seat designed to be straddled by the operator and handlebars for steering control.
An ORV	A motorized vehicle designed for off-road use that is 35 inches or less in width, having an unladened dry weight of 450 pounds or less, traveling on two tires and having a seat designed to be straddled by the operator and handlebars for steering control.
Multiple-Use Trails	Includes all forest system trails that are open for travel by all recreation travel including two wheeled motorized (ORV), bicycling, horse, and foot travel.
Non-Motorized Trails	Forest trails that are open to hikers, pack and saddle stock, bicycles. These trails are closed to motorized travel.
Non-Wheeled Trails	Forest trails closed to all wheeled travel, including motorbikes and bicycles.

Appendix I
to
WATERSHED ASSESSMENT
Entiat Analysis Area

Analysis Team Members
Watershed Assessment
Version 1.0

MODULE	PERSONNEL
1. **Vegetation**	Randall Walker - Ecologist; Terry Lillybridge - Plant Ecologist
2. **Wildlife**	Charles Phillips, Camryn Lee, Tom Burke & Pete Forbes - Wildlife Biologists
3. **Soil/Water/Fish**	Carl Davis - Soil Scientist; Amy Unthank, Phil Archibald, Jackie Haskins and Pierre Dawson--Fish Biologists; Tom Robison & Rick Edwards - Hydrologists
4. **Scenery**	Henry Maekawa & Barbara Jackson - Landscape Architects
5. **Watershed History**	Candace Corn, Historian
6. **Overall Support**	Jim Furlong - **Team Leader**; Troy Corn - Fire Specialist; Michelle Ellis - Fire Management Officer; Ken Fredericks - Writer/Editor; Karin Whitehall and Tom Graham - Management Oversight; Darlene Robbins - Editor
7. **Geographic Information System, Mapping and Photo Interpretation**	Pat Murphy, Nancy Belt, James Colegrove, Donna Larsen, Michelle Davis, Mike Davis, Ernie Stutzman and Andy Hoder
8. **Other Agency Participation in Analysis, Synthesis and/or Review**	Jim Fisher, Dana Peterson, Joe Kelly, Kim Sherwood, USDI-BLM; Tim McCracken, Dave Carrie & Bill Noble, USF&WS; Bob Steele and Larry Lavoy, WA DF&W; Phil Jones, NRCS and Chelan County Conservation District

Analysis Team Members
Watershed Assessment
Version 2.0

MODULE		PERSONNEL
1.	**Vegetation**	Terry Lillybridge - Plant Ecologist; Tom Graham - Silviculturist
2.	**Wildlife**	Tom Burke, Camryn Lee, Amy Salveter - Wildlife Biologists
3.	**Soil/Water/Fish**	Phil Archibald - Fish Biologist; Claudia Narcisco - Geologist; Carl Davis - Soil Scientist
4.	**Scenery**	Henry Maekawa & Barbara Jackson - Landscape Architects
5.	**Ranges Resources**	Les Julian, Bobbi Neibauer & Carl Davis - Range Specialists
6.	**Recreation Resources**	Randy McLandress, Recreation Specialist
7.	**Watershed History**	Candace Corn, Historian
8.	**Overall Support**	Rick Edwards - **Team Leader**; Kathy Kuennen-- Writer/ Editor; Troy Corn & Michelle Ellis-- Fire Specialists; Barry Marsh--Engineering; Karin Whitehall - Management Oversight; Dan O'Connor & Rick Carter - Graphics
9.	**Geographic Information System, Mapping and Photo Interpretation Support**	Pat Murphy, Nancy Belt, James Colegrove, Donna Larsen, and Michelle Davis
10.	**Other Agency Participation in Analysis, Synthesis and/or Review**	Jim Fisher, Steve Slavik, Joe Kelly & Dana Peterson, USDI-BLM; Tim McCracken, USFWS; Lee Carlson, Yakama Indian Nation; Andrea Mann-Lower, NRCS; Phil Jones & Phil McColley, Chelan County Conservation District

Appendix J
to
WATERSHED ASSESSMENT
Entiat Analysis Area

WATERSHED RESTORATION PROJECTS

Watershed restoration needs exist throughout the analysis area. Ecosystem function is degraded at these sites to varying degrees, depending on the location and magnitude of disturbance and the sensitivity of the area. The goal is to fully restore or establish an improving trend at degraded locations, based on the desired ecological conditions identified in the Management Strategy tables in Chapter 3 and those derived from subsequent site-specific analyses.

The priorities for development of restoration projects are reflected in Table 5.1 (Management Strategy Priorities). Initial emphasis will be placed on the following categories of projects: (a) burned area recovery; (b) projects that move landscape toward a more resilient condition that is better able to handle perturbations or withstand wildfire and insect/disease epidemics; and (c) access manangement projects designed to improve surface water control, reduce accelerated erosion/sedimentation, increase wildlife security and reduce maintenance costs.

Following is a list of specific restoration projects proposed to date that respond to the priorities in Version 1.0 and 2.0 of this Assessment. This list is not exhaustive, but rather provides a sense of the range and scale of potential projects.

ACCESS MANAGEMENT

Analysis

1) Complete Three Creeks Recreation Analysis (includes ATM; trail re-locations; trail hardening; road closures, road-to-trail conversions, joint use by vehicles and trail bikes on some routes).

2) Coordinate access management analysis and road rehabilitation work with the other following landowners: Longview Fibre (intermingled), WaDNR (intermingled), BPA (major transmission line ROW roads), and BLM.

3) Complete ATM for the following resource areas. The scheduling of analysis for these areas will be dependent on funding issues (for analysis and implementation) and ability to re-survey roads:
   a) Upper Entiat (Mott->Upper Tommy, Lake Cr & Headwaters;RAs 1, 2, & 4)
   b) Stormy->Fox Creek (RA #3)
   c) Ardenvoir->Berg Creek (RA #5)
   d) Dick Mesa->Gray Canyon (RA #6)
   e) Roaring Ridge->Miners (RA #7)
   f) Swakane->Roaring Ridge (RAs #8 & 9)

Roads

1) Riparian road obliteration/re-locations:
   a) North Fork Potato Creek Road.
   b) Potato Creek Road (sections above NFK).
   c) Middle Fork Mud Creek.

d) South Fork Mud Creek.
e) Upper Crum Canyon Road (to Dick Mesa).
f) Other sections.

2) Design and implement the following road rehab projects. Tentative scheduling is indicated below. "Road Rehab" projects involve a variety of treatments, including drainage improvement, flood/runoff damage repair, spot surfacing, erosion control on cuts and fills (armoring, mulching, seeding, planting), culvert cleanout/repair, road closures (gates, berms and road obliteration. Priority will be given to completing BE-mandated road rehab projects:

a) 1996
* Early Entiat Road Rehab (Tyee Fire area emphasis)
* Tillicum-Chiwawa LSR Road Rehab.
* Tyee-Berg Road Rehab.
* Shady Lake LSR Road Rehab.
* Late Entiat Road Rehab (Tyee Fire area emphasis)

b) 1997
* Early Entiat Road Rehab (Tyee Fire area emphasis)
* Swakane-Mills-Roaring Road Rehab (include USFWS $$ for private roads).
* Dick Mesa-Potato Creek Road Rehab.
* Stormy-Fox Creek Road Rehab.

c) 1998 & beyond
* Stormy-Fox Creek Road Rehab (if not implemented 1997).
* Tillicum-Tyee-Berg Road Rehab.
* Tommy-Lake-Pope Road Rehab.
* North Fork-Cottonwood Road Rehab.
* Continue implementation on priority basis

Trails/Trailheads

1) 96-97 (IAC) - Upgrade Lake Creek Trail System (repair and harden all stream crossings, install turnpiking through all wet areas, improve trailway drainage; 14 miles (concrete grid blocks, culverts, drain dips).

2) 96-97 (IAC) - Upgrade and reconstruct the lower end of Cougar Ridge Trail from the 5700 Road to Mad River. This project will reduce grades,install trailway drainage and trailway hardening were needed. Two miles.

3) 97-98 (IAC) - Upgrade and Reconstruct Duncan Hill Trail #1434 6.8 miles work same as above but will have approx 2.5 mile relocation.

4) Trailbridge construction at Maverick Saddle (replace existing ford on Trail #1409).

5) 96 (IAC) - Upgrade Lake Creek Trailhead, this project will replace old pit toilet with new vault type, install parking barriers, and resurface parking area.

6) 97-98 (IAC) - Silver Falls NRT and Entiat River Trailhead upgrades work same as above.

7) 96-98 - Repair damage related to Tyee Fire:
   a) Hornet Ridge Trail - reconstruct to Most Difficult level. Reduce grade, install trailway drainage, and trailway hardening where needed.

b) Miners Ridge Trail - repair fire suppression damage and reconstruct to More Difficult level, as in Hornet Ridge Trail above.

RIPARIAN AREA/STREAM CHANNEL

1) Road Rehab - All of the access management projects listed above emphasize rehab work in riparian areas as highest priority.

2) Swakane Canyon Beaver Habitat - Armoring stream crossing to accomodate beaver use of road fill and culvert as dam (1996).

3) Remove wrecked vehicle, camper, and associated debris from unnamed Class IV tributary stream to Mad River near Pine Flat Campground (1996).

4) Aquatic habitat connectivity - correct partial/complete passage barriers:
   a) Tillicum Creek (one crossing; 1996).
   b) Indian Creek (one crossing; 1996).
   c) Entiat Falls rootwad (relocation from notch in Falls to pool below).
   d) Stormy Creek (two culverts; re-evaluate in 1996).
   e) Rock check dam evaluation and rework (fire rehab; Stormy Creek rework 1996).
   f) Water Chance Reconstruction (fire suppression facilities, as needed).

5) Streambank Stabilization/Riparian Planting:
   a) Tillicum Creek Fan (1996).
   b) Cottonwood Campground.
   c) Entiat River Streambank Rehab (eroding bank near Potato Creek confluence).
   d) North Fork System (S Pyramid Creek, Crow Creek).
   e) Riparian planting - Indian Creek (1996), Roaring Creek, other burned area sites.
   f) Fox Creek vicinity alluvial fan.

6) Reconstruction of Entiat Spawning Channel.

7) Revegetation of Mud Creek Meadows (incl noxious weed control).

8) Rehabilitation of sanitation facilities at developed campgrounds:
   a) Replace all old pit toilets in District campgrounds with new vault type.
   b) Repair basements of newer composting toilets (correct design flaw).

9) Rehabilitation of Cottonwood Campground - Bank stability, vegetative ground cover and access control.

SOIL QUALITY/VEGETATION MANAGEMENT

1) Access Management: Most of the projects listed under access management and riparian/stream channel involve some level of revegetation/soil productivity improvement work.

2) Soil quality restoration:
   a) Continue maintenance/supplementation of Tyee Fire burned area rehabilitation work.
   b) Cooperative projects with USFS Wenatchee Forest Science Lab on selected sites; designed to promote recovery processes in soils with residual detrimental disturbance (Middle Fork Mud Creek).

3) Reforestation of priority areas:
   a) Tyee burn sites (on-going), estimate 25,000 acres.
   b) City of Seattle Lands acquired in 1995 (begin in 1996; include site condition survey).

4) Shrub/forb/grass revegtation for wildlife:
   a) Plant/seed/fertilize preferred vegetation to increase forage and improve security/thermal cover in burned areas, where needed to supplement natural recovery (especially thermal cover on winter range; Potato Creek-Johnson Creek area).
   b) Pruning - Medicine Ridge/Miners Gold timber sale area.
   c) Continue with native seed collection/propagation program.

5) Fire recovery salvage projects (Tyee Fire Recovery Program):
   a) 1995: Cub, OK, Baked Spud, Tater Tot, and Pa Bear.
   b) 1996: Round-up, Mad Billy, Gold Springs, Flying BB, Dilly, and Mad Hornet.

6) Noxious weed control:
   a) Road rehab projects (especially closures/obliterations and open road revegetation).
   b) Tillicum Fan revegetation (see riparian).
   c) Mud Meadows revegetation (see riparian).

7) Fuel Break Management
   a) Tyee Fire area fuel breaks (1996-98) - reduction of fuels in areas identified through fire recovery project planning.

WILDLIFE HABITAT

Project implementation based on priority species

1) Improve Wildlife Security:
   a) Access management: Reduce road densities where needed to improve habitat effectiveness of limited habitats - See Access Management actions above (includes closures, obliterations, riparian road re-locations, enforcement of winter recreation access restrictions, etc.)
   b) Promote vegetative screening: planting along existing roads and in roadway of closed/ obliterated roads; on priority sections under Access Management
   c) Various projects to protect known nest sites in more susceptible, key habitats (e.g., snag signing Potato Creek-Johnson Creek, Tyee Ridge)

2) Shrub/forb/grass revegtation for wildlife: See vegetation section above

3) Structural Improvements:
   a) Nest/den structure installation in habitats where they are limited (e.g., bird/bat boxes in Tyee Fire priority areas; Potato-Johnson Creek)
   b) Guzzler maintenance; additional installations, especially along Columbia River tributaries
   c) Riparian fencing (associated with active allotments)
   d) Nutritional supplementation - selenium blocks for Swakane Bighorn Sheep
   e) Beaver habitat - Road reconstruction in Swakane Creek (1996) - See Access Management section above.

RANGE RESOURCE

1) Repair of Tyee Fire-damaged range improvements (fences, cattleguards) in existing allotment.

2) Relocate stock water tanks out of riparian areas.

3) Protection (via fencing, salting, riding, temporary water sources) of springs/riparian areas from direct livestock impacts in the Roaring-Mills temporary pasture.

Appendix K

Index to Management Strategies in Tables 3.2 to 3.7
Watershed Assessment - Entiat Analysis Area

Index to Management Strategies

MS #	Management Strategy Topic	Applicability *	Text Page
1 & 2	Riparian & Wetland Function	Common	50
3 & 4	Soil Quality & Hydrologic Function	Common	51
5	Tyee Fire - Flood Risk	Common	51
6	Critical, Unique & Key Species & Habitats [plants, wildlife & aquatic]	Common	51
7	Road and Trail System	Common	52
8	Noxious Weeds	Common	52
9	Burned Area Rehab Seeding	Common	52
10 & 11	Planning Coordination	Common	53
12	Inventory/Monitoring Coordination	Common	53
13 & 14	Landscape Appearance	Common	53
15	Snags and Logs	Common	53
16	Recreation Planning	Common	54
17-19	Developed Recreation Uses-Site Impacts	Common	54
20	Developed Recreation Sites-Safety Concerns	Common	54
21 & 22	Dispersed Recreation Use-Site Impacts	Common	55
23	Change of Viewshed-Smoke & Dust Impacts on Air Quality	Common	55
24	Expectation of Quality Recreation Facilities	Common	55
25	Domestic-Bighorn Sheep Contacts	Common	55
26	Native Aquatic Biota	Common	56
27	Pre-Attack Facilities	Common	56
28 & 29	Altered Vegetative Structure & Condition - Fire	SS	57

Index to Management Strategies (continued)

MS #	Management Strategy Topic	Applicability *	Text Page
30	Altered Vegetative Structure & Condition - Grazing	SS, OF	57
**	Mule Deer Cover & Forage	SS	57
31	Human Activities in Mule Deer Winter Range	SS OF CF	58
32	Grouse Populations	SS	58
33	Cover for Ground-Nesting Birds	SS OF CF	58
34	Riparian Vegetative Structure & Condition	SS OF	58
35	Unique Habitat - Columbia River Breaks	SS OF	59
36	Large Woody Debris	SS OF	59
**	Erosion/Sedimentation	SS OF	59
**	Riparian Road Density	SS OF	59
37	Stream Channels	SS OF	59
**	Fish Habitat	SS OF	60
38-41	Landscape Appearance	SS	60
42	Change of Viewshed - Road Density	SS OF CF	60
43	Change of Viewshed-U.S. Hwy 97, 97A (US Hwy 2) and Hwy 971 - Segment of Cascade Loop Tour	SS OF	61
44	Range Allotment Conditions	SS OF CF	61
45	Wildlife-Domestic Forage Competition	SS OF CF	61
46-48	Altered Vegetative Structure & Condition - Recent Fires	OF	62
49	Altered Vegetative Structure & Condition - Unburned Areas	OF	62
50	Mule Deer Forage & Cover	OF	62
**	Landscape Appearance	OF	63
51	Recreation Facilities - Protection	OF CF	63
52-54	Successional Stages	CF	64
**	Fuel Loading	CF	64

Index to Management Strategies (continued)

MS #	Management Strategy Topic	Applicability *	Text Page
55	Large Diameter Trees	CF	64
56	Carnivore Habitat Limitations	CF CS	65
57	Existing Debris Slides	CF	65
58-59	Large Woody Debris	CF	65
**	Primary Pools	CF	65
**	Aquatic Habitat Diversity	CF	65
60	Landscape Appearance	CF	66
**	Successional Stage	CS	67
61	Groundwater Interception	CS OS	67
**	Stream Channel Confinement	CS OS	67
**	Primary Pools	CS OS	67
**	Fish Habitat Condition	CS OS	68
**	Landscape Appearance	CS	68
62	Meadow Succession	OS	69
63	Whitebark Pine	OS	69
64	Sheep Grazing Effects	OS	69
**	Zone Composition [vegetation for wildlife]	OS	69
**	Landscape Appearance	OS	69

* Applicability - Vegetative group(s) to which the management strategy applies:

Common = Applicable to all vegetative groups
SS = Shrub/Steppe
OF = Open Forest
CF = Closed Forest
CS = Closed Subalpine
OS = Open Subalpine

** No unique ID number was attached to this management strategy, as it is represented by one or more of the strategies already identified.